NATURAL RESOURCES - REPORTS (Comments)

8.

RECONNAISSANCE OF MINERAL DEPOSITS
In A Part Of
WESTERN SAUDI ARABIA

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United States of America Operations Mission
to Saudi Arabia

Jeddah, Saudi Arabia
July 25, 1954

COPY

American Embassy
Jidda, Saudi Arabia
July 25, 1954

Mr. Glen F. Brown, Chief
Natural Resources Division
USAOM - U.S.G.S.
Jidda, Saudi Arabia

Dear Sir:

Enclosed please find the report on the mineral deposits I examined during the past field season from January 11, 1954 to June 2, 1954.

Three places, Dahlhalot Shabab, Sidria, and Samrah, appear to have possibilities. Four other places, Ishmas, Obu Esnoen, Jebel Ahrayhyah and Jebel Yanoofi, appear favorable and warrant further work. Suggestions have been made for further exploration at all of these deposits.

The report has been divided into three main divisions: The first, introduction and general geology; the second, ore deposits (general) and methods and criteria used during this reconnaissance for finding mineralized areas; and the third, which is the principle part of the report, contains a description of the individual mines and showings of mineralization.

Sincerely,

Richard G Bogue

Richard G. Bogue
Geologist

Enclosure -
as above

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Western Saudi Arabia

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Reconnaissance of Mineral Deposits
in a part of
Western Saudi Arabia

Richard G. Bogue

INTRODUCTION

The purpose of investigation was to find ore of economic grade for the mill at the Zhalm mine. The work was done at the request of the Saudi Arabian Government as part of the program of the Natural Resources Division of the United States of America Operations Mission to Saudi Arabia in cooperation with the United States Geological Survey.

The development of the Zhalm (Jiffen Orimba) mine and mill was undertaken by the Saudi Arabian Government to exploit ore deposits in ancient workings. Development of the mine has been in progress for several years and the mill was completed in March, 1953. The mill was operated for three months on stock piled ore. The grade of ore was too low to be milled at a profit.

In October 1953 an examination of the mine was made by Mr. K. S. Twitchell, Consulting Mining Engineer, and myself, and a joint report submitted.[1] It was recommended that the work at the Zhalm mine be stopped due to the low grade of ore and a search be made for deposits of economic grade where the mill and mining equipment could be used.

Mr. D. F. Schaffner, Mining Engineer for the Saudi Arabian Government, has examined ancient workings and quartz outcrops near the Zhalm mine. However, his duties at the mine prevented him from making long trips. It was agreed, between Schaffner and myself, that he would confine his search to the Zhalm district and I would search for deposits to the east and northeast. It was also agreed that if any likely prospects were found, Schaffner would bring a crew of men to do enough excavation to secure adequate samples. This was done at three places, Um Hadid, Ishmas and Dahlhalot Shabab.

The trip was divided into two parts, the first from January 11 to April 7, 1954, and the second from April 18 to June 2, 1954. The period from April 8 to April 17, 1954, was spent in Jidda repairing equipment, replenishing supplies and changing personnel. A total of 7,808 miles was traveled on the two trips.

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[1] Numbers refer to Bibliography.

The area covered is in the western part of the Kingdom of Saudi Arabia (Lat. 20°30' to 24°30' N., Long. 42° to 45° E.) about midway between Riyadh and Jidda. The larger towns in the area are Duwadami, Afif, Khurma, Haliban and Bisha. The southeastern portion of the area is called the Nafud or Nafud Dahi. Locally the people call this eastern part the Rub al Khali, the Empty Quarter.

Acknowledgments

The staff at the Zhalm mine, Mr. D. F. Schaffner, Mr. L. McGary and Mr. W. W. Yandel were very cooperative and assisted in every way possible. Mr. Schaffner assayed the samples.

The Emir of Zhalm, Ayidh al Ma'boud, was very helpful, as were the Arab personnel which accompanied me. I wish to mention especially the guide, Hamud Atik, and the driver, Mohamed Matlub, who also had charge of my camp.

Mr. Schaffner and I were together when the ancient workings at Ishmas were discovered. Mr. R. O. Jackson was with me when the ancient mines at Samrah were found.

Previous Work

There has been no previous geological work in most of the region. Geologists of the Arabian-American Oil Co. have scouted the eastern part for the possibilities of petroleum but apparently were not interested in searching for mineral deposits.

Mr. D. F. Schaffner found the ancient workings at Aduwaha. The Chief of Police at Duwadami said that Mr. H. St.J. B. Philby had seen the workings at Sidria but no reference to these deposits has been found in his writings.

During World War II the United States Air Force photographed the northwestern part of the region.

As far as known, this was the first reconnaissance made in the region for the specific purpose of finding mineral deposits.

GEOLOGY

As this was a reconnaissance trip in search of ore deposits, practically no detailed work was done on the general geology, stratigraphy and structure of the region as a whole. Some detailed work was done at the larger and more promising mineralized areas. The general stratigraphy was worked out to aid in the search for ore deposits.

The oldest rocks in the area are a series of sediments, mostly shales and sandy shales with occasional beds of sandstone, conglomerate and impure limestones. Near the igneous intrusions these sediments have been metamorphosed to slates, phyllites and schists. These sediments are similar to the sediments found in Northern Arabia which were called the Silasia.[2] No work has been done between these two areas. It is not known if the sediments are the same in both areas so to avoid giving the same formation two names, these sediments are simply called the older sediments in this report.

Following the deposition of the sediments, the area was faulted and large masses of igneous rocks were intruded into the area. Most of these rocks are albite granite but some monzonite, quartz-monzonite and syenite have been found. No attempt was made to work out the petrology or sequence of these intrusions as they are not genetically connected with the mineral deposits. These igneous intrusions are the same type rocks found in northwestern Arabia which were called the Cave and Massive granites[2] but in this report are simply called the older granites.

The next oldest sedimentary formation is a thick series of conglomerate and limestone. The best exposures of this formation are near Bir Wurshaw and Dahlhalot and in both places there is a distinct unconformity with the older sediments.

After the deposition of the conglomerate-limestone series there was erosion and volcanic activity. A variety of both intrusive and extrusive rocks came into the area during this period. The rocks are mostly andesite and fine grained diorite but gabbro, basalt and basalt porphyry are not uncommon. These volcanic rocks are probably the same as those called the Shammaq, in northwestern Arabia.[2] The intrusion of these volcanic rocks caused widespread alteration and introduction of epidote into the older rocks.

Following the period of volcanic activity the area suffered considerable erosion and another intrusion of acidic rocks. These intrusions are probably of the same period and type which in northwestern Arabia were called the Red group.[2] The rocks of this period are mostly orthoclase granite but there is some syenite and locally monzonite and quartz monzonite. The smaller intrusions, dikes and sills are fine grained and are rhyolite and rhyolite porphyry.

There is good evidence that these rocks and the ore deposits are genetically related. In almost all of the larger intrusions, small amounts of sulphide ore minerals may be found associated with the deuteric minerals. Intrusions of this rock are found at or near the mines and mineralised areas and at Samrah quartz veins containing ore minerals may be traced from an intrusion to the veins worked by the ancient miners.

There is another formation in the area but the age relations with the other formations could not be determined with certainty. This formation is a gray to pink limestone and is unconformable over the oldest sediments and schists, the oldest granite and the volcanic series (Shawak?). It was not found in contact with the later granite (Red group?) so it is not known whether it is younger or older than these rocks.

The age of these formations was not determined. No fossils were found in the sedimentary rocks. However, this entire series is probably pre-Cambrian in age. They are part of the complex series of ancient rocks exposed along the western coastal region of Arabia.

Ore Deposits

The mineralization in the region is widely distributed but there are certain general characteristics common to all the deposits. The characteristics and associated minerals indicate that the mineralization is generally mesothermal but a few veins near the granite intrusions exhibit characteristics of low hypothermal.

Mineralization is found at or near the intrusions of the late granite series (Red group?). The ore minerals are found in quartz veins which have been emplaced in and along fault zones, and only scattered ore minerals and low gold values were found in the adjacent wall rocks. No widespread mineralization or impregnation of the country rock by ore minerals was found in the entire region.

The chemical composition of the country rock had little effect upon the deposition of the ore minerals. Deposits and evidence of mineralization are found in the fault zones in all of the older rocks. However, the best and largest showings of mineralization are in the more competent rocks where the faulting has caused extensive fracturing and brecciation, as in the granite at Sidria and Samrah. The showings of mineralization in the fault zones in the more incompetent rocks, as in the shales and limestones west of J. Um Hatierah, are not large or persistent.

The gold and other ore minerals are associated with a white or bluish-white to gray vein quartz. This quartz is readily distinguished from the earlier pegmatite type of quartz which came from the older granite. There are a number of places where the ore-bearing quartz is found associated with, and intruded into, the earlier pegmatite quartz as at Um Hugsahr, J. al Letchathahl and Bir Hayaniya.

The ancient miners have prospected the region quite thoroughly. They apparently recognized the two different types of quartz and practically all outcrops containing the ore-bearing quartz show evidence of ancient work. The ancient miners apparently did not recognize or ignored the relation between the quartz veins and the hydrothermal alteration of the country rock. Workings are found only on the veins which outcropped and there was no attempt made to locate veins beneath altered rock or even veins which are covered with sand, gravel or soil.

A large number of showings of mineralization were found but most were too small or low grade to be of economic value. Three places were found that appear to have definite possibilities -- Sidria, Samrah and Dahlhalot Shabab. Two other places - Obu Zenoon and Ishaas - may have possibilities but not enough work has been done to make even a preliminary evaluation. The above places are all showings of gold-silver mineralization. The limonite outcrops at Jebel Ahrayhyah and Jabel Yanoofi should be investigated as it is possible that they are gossans over sulphide ore bodies.

Conclusion

This was a general reconnaissance of a large area for the purpose of locating districts of mineralization. No attempt was made to make detailed examinations. At the more promising prospects, preliminary examinations were made and samples taken for the purpose of gathering enough data to see if further, more detailed work, was advisable. Further work is advisable at a number of places and specific recommendations are made in the descriptions of the individual mines and districts.

Criteria and Methods

The criteria and methods used during this reconnaissance were successful in locating the districts and mineralized areas.

1. The mineralization has been found to be genetically related to the late granite type rocks (Red group?). These rocks are in most places readily distinguished from the older granites and when exposures of these rocks are found there is usually mineralization at or near the contacts and in the same general vicinity. During the search for ore deposits in this region it was found that one of the most efficient methods was to find the intrusions of these rocks and then examine the nearby area.

2. Old workings in a district are helpful. The ancient miners have prospected the region and workings are found on the outcrops of the quartz veins. The local herders often know of these workings and will act as guides.

3. There are areas which show alteration of the country rock in which there are no quartz outcrops. The ancient workings at Dahlhalet Shabab were found by the altered rock exposed over a mile from the quartz vein outcrops. Weathering usually causes considerable bleaching of the altered rock and these areas are generally prominent. However, weathering of the altered rock near the pegmatite quartz is often similar, but in most places can be distinguished from the alteration caused by the ore-bearing quartz.

4. Fault zones containing silicified fault breccia are guides to mineralization. These fault zones in which the breccia is silicified are more resistent to erosion and form low ridges. Most of the silicification has been caused by barren quartz but the fault zones locally contain ore, as at Sidria and Samrah, which has been introduced by the later, ore-bearing quartz along the same zones.

5. The late granite intrusions are widely scattered over the entire region. However, many have been intruded along the contacts of the older granite batholiths. The contacts are barren except where there are intrusions of the late granite. It was found that it was advisable to scout these contacts to locate the intrusions of the late granite and any associated mineralization.

6. The presence of pegmatite quartz in an area may indicate mineralization if there are intrusions of late granite. The ore-bearing quartz has been found introduced along the same fractures and associated with the pegmatite type of quartz. However, if there are no intrusions of late granite in the area, there is no mineralisation of economic value.

7. One showing of mineralization, Bir Rayania, was found by the presence of ore-bearing quartz in the wadi gravels and tracing the fragments to the source. However, this method has been of little value on this reconnaissance but probably could be used to advantage if more detailed work were done in the region.

8. Sampling is necessary as no criteria could be found that were reliable to indicate the gold values. The quartz contains free gold but only one small speck has been found and determined. The presence of sulphide ore minerals indicates the ore-bearing variety of quartz but does not indicate the gold or silver values. Galena may indicate the presence of silver. The quartz at Samrah, Sidria and Um Hadid contains a fine, granular galena which generally is covered with a dark coating. This galena is probably the silver bearing variety. Small amounts of argentite are present in the ores but not enough to give the high assays. Galena is also found at a number of other places which are low in silver values. This galena is in well-formed crystals and has a bright metallic luster.

Description of Mines

Sidria

The ancient mine workings at Sidria were found May 24, 1954, and four days were spent in the area. The shortage of time did not permit an examination or even a reconnaissance of the entire district. The sampling and examination was confined to the larger workings and the nearby area, totalling about four square miles.

Location

The Sidria area is located 2 1/2 to 3 1/2 miles northwest of the town of Duwadami at Lat. 24° - 30' N., Long. 44° 15' E. The elevation is about 3,300 feet (Aneroid).

Geology

The oldest formation in the area is sedimentary which has now been metamorphosed. The original sediments were mostly shales with some beds of sandy shales and impure limestone. The sediments have been metamorphosed by granite intrusions and are now mica schists and mica-hornblende schists.

There have been two, and possibly three, granite intrusions into the area. Two are easily recognized in the field but detailed work would be necessary to determine if the third were a separate intrusion or a phase of the older type.

There are some andesite and fine-grained diorite dikes in the area. These dikes have probably been intruded before the period of mineralization. However, evidence could not be found to determine with certainty the age relations of these dikes and the ore-bearing quartz veins.

Structure

The schistosity in the metamorphosed sediments has a general trend of N. 20° - 30° W. The early granite intrusions have an elongation in this same direction and apparently have been intruded along faults. In the vicinity of the workings evidence of these earlier faults is almost totally destroyed.

There is a later system of faults which have a general trend to the northeast. The intrusions of the later granite and the ore-bearing quartz veins have been emplaced along these faults and the adjacent fractures.

Ore Deposits

History and Production

It is not known when the deposits were discovered but there are fragments of pottery in the old village which indicate that these mines were worked about the eighth or ninth centuries B. C.

It was not possible to make an accurate estimate of the production from the ancient workings. Many are caved and filled, or partially filled, with sand and debris and as stated above the shortage of time did not permit detailed work. The total production from the four square mile area is probably not less than 40,000 to 50,000 tons. Of this tonnage, between 20,000 and 25,000 tons came from the main workings. Much of the tonnage was barren rock and there are large waste dumps near the workings. It is estimated that there are between 8,000 and 10,000 tons of rejected ore in the sorting areas and ground ore in the tailing dumps.

Scattered piles of slag are found in the area and it is estimated that there is not less than 200 tons.

General Character

The ore minerals are found in silicified breccia and quartz veins which have been emplaced in fault zones and adjacent fractures. The larger fault zones are easily recognized and some may be traced along strike for several miles. Silicified breccia and quartz veins are found along the entire length of the fault zones. However, the distribution of ore minerals is erratic. Only certain parts of the mineralized fault zones contain ore minerals in sufficient quantities to be mined.

Evidence in the field indicates that the major silicification in the fault zones was caused by the introduction of a white quartz which contains small amounts of hematite and pyrite. The ore minerals were introduced with a later, white to gray quartz along the same fractures. This later ore-bearing quartz was introduced in only certain places along the fault zones where there had been fracturing and brecciation after the silicification.

There is early, barren, white quartz in the area which usually contains some feldspar. This quartz is found intruded into the schists and along the contacts of the early granite and is probably a pegmatite from the granite intrusions. It is easily distinguished in the field from the later barren and ore-bearing quartz.

Mineralogy

The ore mined and milled by the ancient miners is a white to gray quartz containing pyrite, chalcopyrite, sphalerite, galena, and hematite. Small amounts of chlorite and serpentine are found in the fractures with the ore minerals. Associated with the chlorite are tiny crystals of argentite, magnetite and molybdenite.

Most of the sulphides in the outcrops and in the weathered portions of the veins are altered to limonite pseudomorphs. Small amounts of chrysocolla, malachite, azurite, chalcocite, and smithsonite were found in the weathered portions of the veins.

Alteration

Two periods of hydrothermal alteration may be recognized in, and near, the mineralized fault zones. The earliest alteration has caused the feldspars of the granites to be altered to sericite, kaolinite, small amounts of hydromuscovite and fine grained carbonate. The biotite is bleached and there are small amounts of granular magnetite at the edges of the crystals. This argillic alteration is not widespread and is seldom found more than a few feet from the mineralized fault zones.

This early alteration is usually masked and in many places destroyed by later silicification. The silicification is intense in the fault zones and for several feet into the wall rocks but in most places the rocks are unaltered and unsilicified six to ten feet from the major fault zones.

Enrichment

There has been some supergene enrichment in the weathered portions of the veins. It is not a prominent feature but apparently the copper content of the weathered ore has been increased slightly by secondary chalcocite.

The ancient miners mined the weathered portions of many small veins in the area but stopped the workings when primary unweathered ore was encountered. The metal content of these veins may have been increased by residual concentration due to weathering.

Genesis

The ore-bearing solutions came from the same magma as the late granite. There is only one small dike-like intrusion of this rock exposed in the area. Small amounts of chalcopyrite and pyrite were found in the rock and there is good evidence that these minerals are of primary origin and not introduced by later hydrothermal solutions.

Grade of Ore

A total of 23 samples were taken from the four square mile area. Of these samples, 14 were taken from the main workings and nine from the smaller workings in the vicinity.

The 14 samples from the main workings were taken from the waste dumps, tailings dumps, sorting areas and the veins in place. Two samples from the waste dumps near the ancient stopes both had a trace of gold and less than one-half ounce of silver. Seven samples from the tailings dumps and sorting areas averaged a trace of gold and 3.41 ounces of silver per ton. Five samples from the veins in the pillars and walls of the ancient stopes averaged a trace of gold and 0.59 ounce of silver per ton.

The nine samples from the smaller workings were taken from waste dumps and veins in place. Four of the samples from the veins in place all contained only a trace of gold and less than one-half ounce of silver per ton. One sample contained 0.01 ounce of gold per ton and 2.95 ounces of silver per ton. The four samples taken from the waste dumps near the workings averaged 0.01 ounce of gold per ton and 2.53 ounces of silver per ton.

The sampling of the workings was unsatisfactory. In the workings the ancient miners have removed all, or practically all, the ore. There are a few pillars but these have been left in the low grade portions of the veins. The lower parts of the workings are filled with sand and debris. The samples do not represent ore which was mined by the ancients but have been taken from parts of the veins which were apparently considered too low grade to be mined. The ore in the waste dumps and sorting areas was discarded by the ancient miners and the crushed ore in the tailings dumps has probably had at least some, if not most, of the ore minerals removed.

The samples taken indicate that there are values in the low grade ore which was discarded by the ancient miners. It is reasonable to suppose that the metal content of the ore was higher than in these samples.

Summary

The district as a whole appears to have favorable possibilities. The mineralization occurs in silicified fault zones of widths and persistence along strike to indicate substantial tonnages if the veins go down to sufficient depths. Veins of this type usually go down to considerable depths but drilling would be necessary to prove persistence at depth.

The samples taken do not indicate ore of commercial grade. However, these samples were taken from tailings and waste dumps discarded by the ancient miners and pillars and veins too low grade to be mined. It is quite possible that ore of economic grade may be found in the district.

There is not enough evidence at the present to recommend or condemn the area. However, there is enough favorable evidence to warrant further work and more thorough sampling.

Recommendations

The following suggestions are offered to test and evaluate the possibilities of the district and at the main workings:

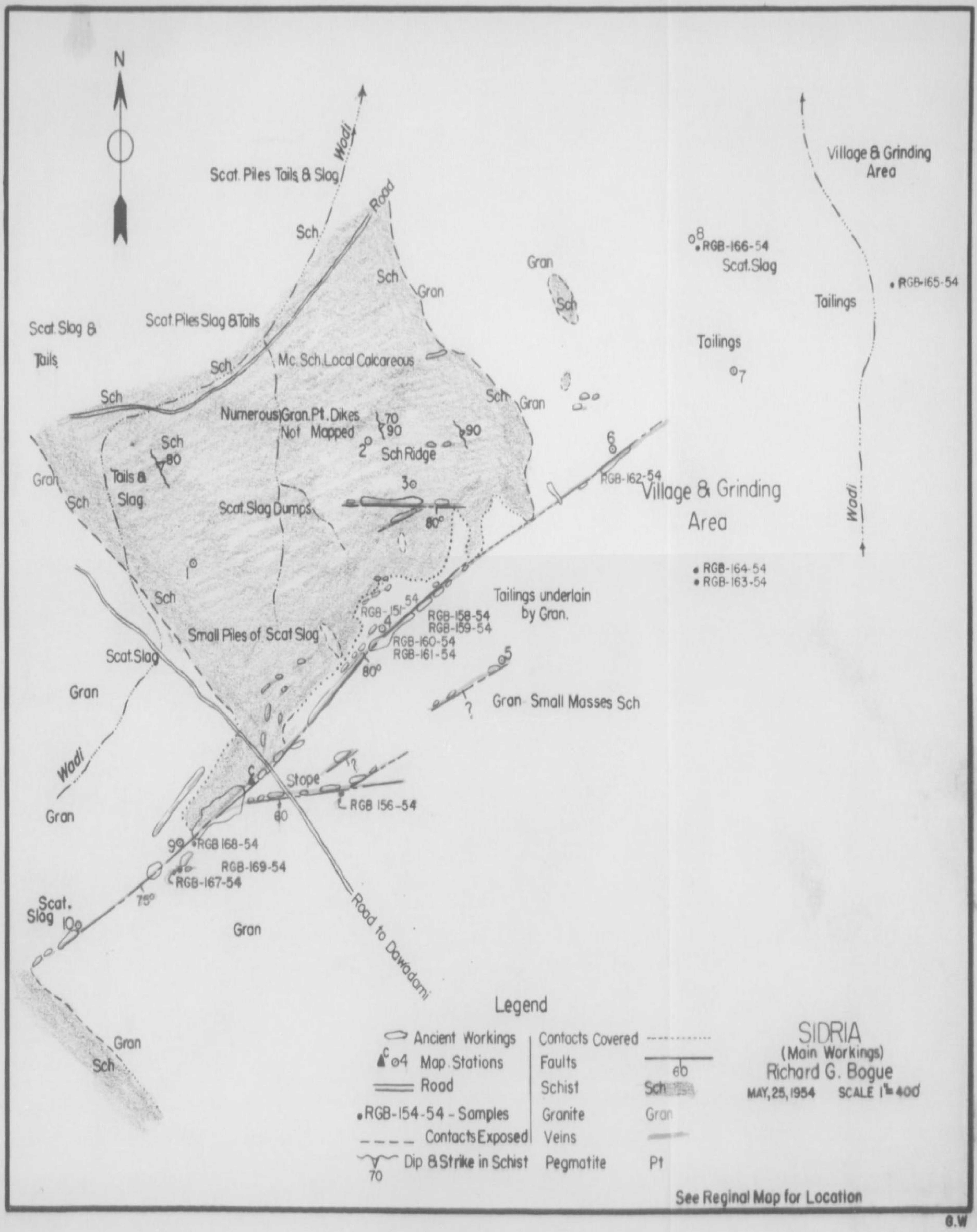
1. Some of the old stopes and trenches should be cleaned out to secure adequate samples of the ore.

2. Test pits should be put down in the tailings dumps and sorting areas to secure samples and estimate tonnage.

3. Diamond drilling will be necessary to prove the widths and grade of ore at depth. A total of eight holes should be adequate. The holes could be drilled from four drill stations spaced 500 feet apart along strike. One hole from each station should intersect the vein at 150 feet and the other at 300 feet below the surface. If the results of this drilling are favorable and indicate ore and adequate tonnage, a more extensive drilling program and possibly underground exploration, should be considered.

4. Some of the larger workings in the four square mile area, outside of the main workings, should be cleaned out and sampled. It would also be advisable to put down pits and trenches on some of the outcrops which were not worked by the ancient miners, as apparently they worked only those outcrops which were high grade at the surface. It is quite likely that due to the erratic distribution of the ore minerals, ore of economic grade may be found beneath barren, or almost barren, outcrops.

5. A thorough reconnaissance should be made of the entire district to look for more ancient workings and other areas of mineralization. This reconnaissance should be thorough enough to find any bleached or altered areas which might indicate ore beneath the surface.



SIDRIA
(Main Workings)
Richard G. Bogue
MAY, 25, 1954 SCALE 1" = 400'

See Reginal Map for Location

G.W

Samrah

The ancient mine workings at Samrah were found May 19, 1954, and four days were spent sampling and examining the larger workings and the nearby area. The following description is confined to the larger workings and separate descriptions are given of the nearby workings at J. Um Mahatah Gabah, Wadi Memruhr and J. Ardahat. There are a number of small workings, mostly single pits and trenches, dug by the ancient miners on the outcrops. The shortage of time did not permit an examination of these but only of the larger, more extensive, workings in an area of about eight square miles.

Location

The workings at Samrah are 12 miles south of the town of Duwadami and 11 miles northeast of the village of Asharah at Lat. 24° 20' N., Long. 44° 15' E. The elevation is 3,350 feet (Aneroid).

Geology

The oldest rocks in the area are mica and mica-homblende schists. These schists were apparently sediments, shales and sandy shales, which have been metamorphosed by granite intrusions. There are two ages of granites. The older is a coarse grained, albitic type with local gneissic structure. Associated with this granite, and apparently the same age, are dikes and irregular intrusions of massive white quartz. This quartz is not mineralized, usually contains feldspar, and is probably a pegmatite from the older granite. This quartz is easily distinguished from the later ore-bearing quartz.

The schists and older granites have been faulted and a later granite and the ore-bearing quartz veins have been intruded along the fault zones and adjacent fractures.

Andesite and fine grained diorite dikes have been intruded into the area. These dikes are probably earlier than the period of mineralization but not enough evidence could be found to determine the age with certainty.

Structure

The structure in the schist is quite complex but in most places is parallel to the contacts of the older granite intrusions. These contacts are irregular but the general trend is north to N. 30° W. If the granite intrusions have been controlled by a fault system, the evidence in the vicinity of the workings has been destroyed.

The ore minerals in the area are found in the silicified breccia and quartz veins which have been intruded into fault zones and the adjacent fractures. The larger faults in this system trend from N. 60° E. to S. 80° E. and generally dip steeply to the south but some are vertical.

Ore Deposits

It is not known when these deposits were discovered but fragments of pottery found in the village indicate that they were worked about the eighth or ninth centuries B. C.

Production

It is estimated that total production from the main workings is not less than 60,000 to 70,000 tons. Much of this was barren rock and there are large waste dumps near the stopes and open cuts.

The tailings were difficult to estimate but there is not less than 15,000 tons. The tailings are scattered and have been dumped on uneven ground and it is not possible to make an accurate estimate without test pits. All of these tailings are not ground ore produced at the main workings. There is good evidence that ore from workings several miles away was brought to the village for sorting and grinding.

Several hundred tons of slag were found to the south and southeast of the village.

General character

The ore deposits at the main workings, and in the district, are found in fault zones and the adjacent fractures. There has been intense silicification of the fault breccia by quartz which was introduced before the mineralization. Small amounts of pyrite, hematite and fine, granular magnetite are found in this early quartz but no ore minerals.

The ore minerals were introduced with a later quartz and are found only in certain parts of the silicified fault zones, apparently in those parts which were brecciated after the early quartz. The ore minerals are confined to the fault zones and adjacent fractures and there is no widespread dissemination of the ore minerals in the country rock.

The fault zones are quite persistent and a number may be traced for several miles along strike but as mentioned above, all parts of the fault zones are not mineralized.

Mineralogy

The ore is a white to gray quartz containing pyrite, chalcopyrite, sphalerite, galena, hematite, granular magnetite and tiny grains of a sectile mineral which is probably argentite. Associated with the ore minerals are sericite, chlorite and serpentine.

In the outcrops and upper parts of the veins the sulphide minerals have been weathered to limonite. Chrysocolla, malachite, azurite, chalcocite and smithsonite were found in the weathered portions of the veins but the amounts are too small to be of any value.

Alteration

There is evidence of an early argillic alteration of the feldspars in the granite wall rocks. Small amounts of kaolinite, hydromuscovite and a mineral which is probably allophane were found but in most places, this early alteration has been masked or totally destroyed by silicification.

Quartz has been introduced during two periods. The first has caused extensive silicification of the fault breccia and the adjacent wall rocks.

This early quartz contains hematite and small amounts of pyrite and magnetite.

The ore minerals were introduced with the quartz of the second period and has caused additional silicification. There is evidence that there was fracturing of the silicified fault zones between the first and second periods and ore minerals are found only in these fractured portions of the silicified fault zones.

There is another type of alteration in the granites which is widespread and earlier than the faulting, silicification and mineralization. Halos of fine sericite, serpentine, granular carbonate, quartz and magnetite were found at the edges of the feldspar crystals. There has been bleaching and some alteration of the biotite to granular magnetite and serpentine. This early alteration is apparently a deuteric effect and is in no way associated or connected with the mineralization.

Enrichment

There has been a small amount of supergene enrichment in the weathered portions of the veins but it is of no economic value. The ancient miners mined the weathered portions of many small veins but stopped when primary ore was encountered. There was probably some residual concentration in this weathered ore.

Genesis

The ore-bearing quartz veins were introduced into the area by the late granite magma. Near the large open cut, there is an outcrop of this granite and large exposures several miles to the north and northwest.

Workings

The largest workings are along a strike length of 1,400 feet on a silicified and mineralized fault zone. The workings consist of two large open cuts and a number of stopes, raises, trenches and pits. Most of these workings are shallow but several stopes go down between 70 and 90 feet below the surface and in places are as much as 15 feet in width. The open cuts go down about 50 feet below the surface. All of these workings were deeper originally as they are now partially filled with sand and debris and some stopes are caved and are inaccessible.

There are a number of workings to the eastward along the same fault zone for a distance of one and one-half miles. Parts of this zone have been mined for distances up to 1,100 feet and to depths as much as 50 feet. There are workings on practically all the outcrops but there is no evidence of trenching to locate the vein in the wadis where it is covered with sand.

Grade of ore

A total of 14 samples were taken from the larger workings, tailings dumps and sorting areas in the village.

The seven samples taken from the tailings dumps and sorting areas averaged 0.02 ounces of gold and 12.31 ounces of silver per ton. The seven cut samples from the workings were taken from pillars and veins which were left by the ancient miners. These samples averaged 0.01 ounce of gold and 3.45 ounces of silver per ton.

Seven samples were taken from the waste dumps and stopes on the eastward extension of this same zone. Three samples of the quartz from the waste dumps averaged 0.02 ounce of gold and 1.52 ounces of silver per ton. Four samples were taken from the veins in the pillars. Two of these were of the early white quartz and both showed only a trace of gold and less than one-half ounce of silver per ton. Two of the samples were of mineralised quartz and contained a trace of gold and averaged 1.55 ounces of silver per ton.

Values in all these samples are probably too low. The cut samples from the veins were taken from the ends of the stopes where the ancient miners had stopped mining and from the pillars in the stopes. The pillars were left in the narrow and apparently low grade portions of the veins.

The samples from the tailings dumps and sorting areas were taken from pits 1 1/2 to 2 feet in depth and represent only the upper portions of the dumps as some are as much as 10 feet in thickness. It would be necessary to trench and pit these dumps to secure representative samples.

Jebel Um Mahatah Gabah

There are some ancient workings approximately one mile S. 35° W. of Samrah near a granite mountain called Jebel Um Mahatah Gabah. The general geology and ore deposits are similar to that at Samrah. The workings are on a silicified and locally mineralised fault zone. The zone strikes N. 70°-80° E, dips steeply, 70°- 80°, to the north and may be traced for a total distance of 1 1/2 miles. The workings are along a strike length of 2,450 feet and consist mostly of shallow trenches and pits. There are two stopes, one which is filled with sand but the dumps indicate that it went down 10 or 15 feet. The other stope is partially filled but is now open for 35 feet below the surface.

As most of the workings are filled, it is difficult to estimate the production but there has probably been not less than 3,000 tons.

Three samples were taken from the dumps and two from the vein. The three samples from the dumps averaged a trace of gold and 4.62 ounces of silver per ton. The two samples taken from the vein in place contained a trace of gold and averaged 5.36 ounces of silver per ton.

Wadi Hemruhr

There are two ancient workings in Wadi Hemruhr, 3 1/2 miles and 5 miles east of Samrah. The workings consist of trenches and pits which are now mostly filled with sand and debris. The waste dumps indicate that the deeper workings probably went down 20 feet below the surface.

The geology and ore deposits are similar to Samrah. The mineralised zones have been mined along a strike length of 500 feet at one place and

1,100 feet at the other. Satisfactory samples could not be obtained at either place. Three samples were taken from the quartz in the waste dumps which had been discarded by the ancient miners. These samples contained a trace of gold and averaged 1.12 ounces of silver per ton. These samples are probably too low and do not represent the ore mined. No tailings could be found at either place and it is quite likely that ore, which was worth grinding, was carried to the village at Samrah.

Jebel Ardahat

There are ancient workings on the west side of the granite hill called Jebel Ardahat. Pits and trenches have been dug along a mineralized fault zone for about 2,000 feet. Near the east end, there is one stope which goes down at least 20 feet below the surface. Most of the workings are filled or partially filled with sand and debris.

The workings are on a silicified and locally mineralized fault zone, which trends N. 80° - 85° W., and dips steeply, 70° to 85°, to the north. It is estimated that a total of 5,000 to 7,000 tons have been taken from the workings. There are about 2,000 tons of coarsely broken ore in the sorting areas and probably about 200 tons of finely ground tailings. However, at least some of the ore from these workings was ground at Samrah. The ore from these workings may be distinguished from that of the other workings in the area as it contains more copper minerals and the serpentine is bleached. Several piles of ore of this type were found at Samrah.

No exposures of ore were found in the workings which were similar to the ore found in the sorting areas. The ore was evidently high grade and the ancient miners have cleaned out the workings. One sample was taken of the early quartz from the end of a stope. This sample contained a trace of gold and less than one-half ounce of silver but the quartz is waste and is not representative of the ore. No other samples were taken due to the lack of sample bags or suitable containers.

Summary

The showings of mineralization in the district look favorable. The mineralized fault zones are persistent along strike and veins of this type usually go down to considerable depths. The samples taken during this brief examination are probably not representative of the ore mined. These samples were taken from the waste dumps, veins in place that were left by the ancient miners and tailings from which part of the values have been removed.

There is not evidence enough to make any definite conclusion on the economic value of the area at this time. There is enough evidence to indicate that the deposits may have possibilities and it is recommended that additional work be done.

RECOMMENDATIONS

It is suggested that:

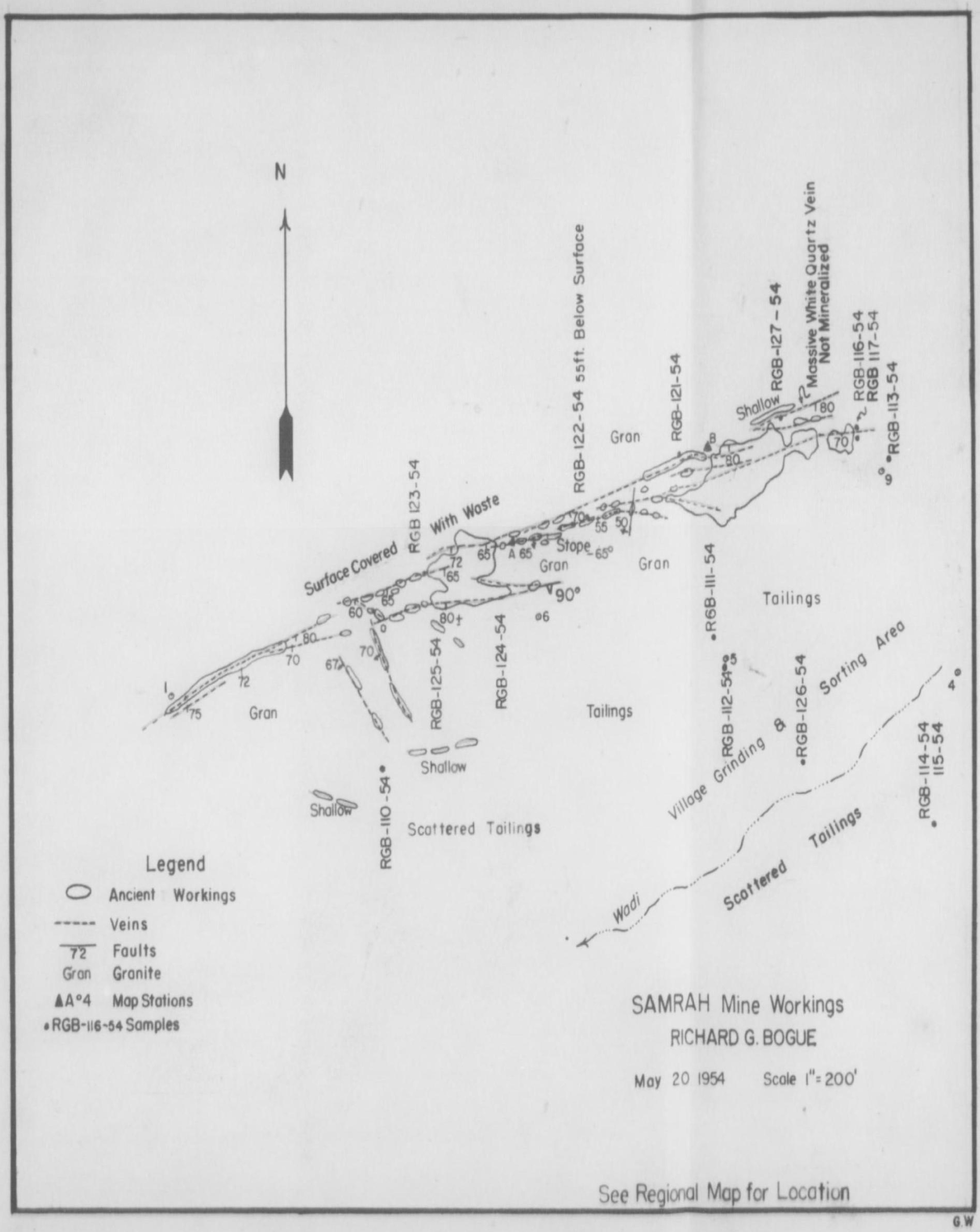
1. At least some of the ancient workings at Samrah be cleaned out to secure adequate samples of ore in place.

2. Test pits be dug on the tailings dumps to get samples and estimate the tonnage.

3. Diamond drilling should be done at Samrah to determine the persistence and grade of the veins at depth. Six holes, drilled from three drill stations 400 feet apart, to intersect the vein at 150 feet and 300 feet below the surface should give this information.

4. If the sampling and drilling at Samrah indicates ore of mineable grade and adequate tonnage, the ancient workings at Jebel Um Mahatah Gabah, Wadi Hemruhr and Jebel Ardahat should be thoroughly sampled and diamond drilled. These three places are within trucking distance of Samrah and could furnish ore for a central mill.

5. A thorough geologic reconnaissance should be made of the entire district to see if there are any ancient workings, mineralized zones and areas of alteration which might indicate ore deposits which do not outcrop.



SAMRAH Mine Workings

RICHARD G. BOGUE

May 20 1954 Scale 1"= 200'

Dahlhalet Shabab

The ancient workings were found March 1, 1954, and a brief examination was made and samples taken. The samples were assayed at the Zhalm mine and the average of the 12 samples was 0.49 ounces of gold per ton. This was encouraging so Shaffner and myself, with a crew of men, went back to the area March 22, 1954. Pits and trenches were dug and a more thorough sampling program was undertaken.

Location

The area is on a small tributary on the east side of Wadi Arahjiyah at Lat. 21° 10' N., Long. 43° 42' E. The nearest town is Bisha about 110 miles to the southwest. The altitude is 2,600 feet (Aneroid).

The entire area is about 2 1/2 miles long and one-half mile in width but the ancient workings and the better showings of mineralization are in an area 1 1/2 miles long and from 1/4 to 1/2 mile in width.

Geology

The oldest rocks in the area are sedimentary, mostly conglomerates with some interbeds and thin partings of sandstone and sandy shale. These sediments have been intruded by dikes and sills of andesite and fine to medium grained diorite. Granite intrusions in the sediments are exposed a few miles from the deposits but none in the immediate vicinity. The conglomerate and other sediments are well indurated and have been metamorphosed at the contacts of the igneous intrusions.

Structure

The sediments in the vicinity of the deposits have a general strike of N. 10° - 30° W., and dip from 10° to 20° eastward. Locally the structure is quite complex, especially near the diorite intrusions and the quartz veins.

There are several periods of faulting in the immediate vicinity of the deposits. The earliest is generally parallel or nearly parallel to the bedding and probably took place during the folding of the sediments.

The second period of faulting occurred before the intrusion of the andesite and diorite as dikes of these rocks have been intruded along the faults and fracture zones. The general trend of these faults is from east to N. 70° E. The dips are vertical or steep to the north.

The latest faults in the area are later than the diorite and have a general trend of N. 20° - 30° E. The ore-bearing quartz veins have been intruded along these faults and the adjacent fractures. Most of the quartz veins are vertical or dip steeply to the west.

Ore deposits

It is not known when the deposits were discovered. Fragments of pottery were found which are similar to those which have been dated as eighth or ninth century B. C.

Mineralization

The mineralization in the area is gold-bearing quartz veins which have been emplaced in fault zones and the adjacent fractures. The gold is evidently very fine and only one tiny speck of metallic gold was seen during the examination.

The quartz veins also contain scattered crystals of pyrite, magnetite, chalcopyrite, sphalerite and galena. The amount of these minerals is very small and of no economic value.

Alteration

The older rocks in the area have been subjected to two periods of alteration. The first was when the diorite sills and dikes were intruded and the second, later period, was when the quartz veins were emplaced. The older alteration caused widespread formation of sericite, epidote and some chlorite in the matrix of the conglomerate.

The later alteration occurred during the emplacement of the quartz veins. The country rock near the veins is bleached and silicified and contains small amounts of clay minerals, mostly kaolinite and a fine micaceous mineral, probably hydromuscovite. Small amounts of pyrite are generally present. However, the bleaching and silicification characterize this alteration and distinguish it from the earlier alteration.

The alteration of this second period is not widespread but found in the vicinity of the quartz veins. The alteration of the country rock in the footwall is generally confined to within a few feet of the vein but in the hanging wall the alteration is more intense and often may be found for considerable distances from the veins. The width of alteration is apparently proportional to the width of the quartz veins i.e., the wider the quartz vein, the wider the zone of alteration. There are several veins which are only a few inches in width at the outcrop but the zone of alteration is quite wide. This would indicate that the veins become wider at depth.

There are several places in the area in which the country rock is bleached and silicified but there are no outcroppings of quartz. It is believed that there are quartz veins below the surface at these places but drilling would be necessary to prove their presence.

Workings

There are ancient mine workings on most of the outcroppings of the quartz veins. Most of the workings are small but there are a few stopes. The stopes are now filled with debris and sand but the waste dumps indicate that some of these went down 30 to 40 feet below the surface.

There are two areas in which rather extensive stoping has been done. One of these stopes is on a single quartz vein and has been mined over a distance of 480 feet. The other stoped area is on several veins over a distance of 900 feet. These are the best and most consistent showings of mineralization in the area.

Sampling

A total of 96 samples were taken from the waste dumps, tailings and the veins (not included are nine samples taken from the wadi gravels). Most of these samples (63) were taken from the quartz in the waste dumps and the ancient sorting areas. This is low grade quartz which had been discarded by the ancient miners.

Thirty-two (32) samples were taken from the quartz veins in place. Most of these samples are from outcrops or shallow pits and were of too low grade to be mined. Some of the quartz vein samples were taken from the stopes but the quartz had been left by the ancient miners, apparently because it was low grade.

Only one sample of ancient tailings was found. This was in the floor of a stone hut in the village.

Grade of ore

As stated above, all the samples taken were from waste dumps, portions of the veins which were left by the ancient miners and outcrops of quartz which were of low grade. It is believed that the ore which was mined was higher grade than these samples.

The thirty-two (32) samples from the quartz veins averaged 0.36 ounce of gold per ton. The 63 samples from the waste dumps and the one of the tailings (total 64) averaged 0.34 ounce of gold per ton. These samples were taken from dumps and exposures, over the entire area.

As stated above, the ancient miners did extensive stoping in two places. The samples from the waste dumps, over a distance of 480 feet, at one stope averaged 0.46 ounce of gold per ton. The quartz vein left by the ancient miners averaged 0.37 ounce of gold per ton. The surface samples, over a distance of 900 feet, from the other mined area, averaged 0.45 ounce of gold per ton. The assays of the quartz left in the pillars and stopes averaged 0.96 ounce of gold per ton. This average is high due to one sample taken over one and one-half inches of vein which assayed 7.73 ounces per ton.

As all of these samples were taken from quartz which either discarded as waste or not mined by the ancient miners, it is believed that the grade of ore is higher, probably averaging about 0.50 ounce of gold per ton.

Tonnage

No attempt was made during this examination to make a detailed estimate of the tonnage. However, a tentative estimate was made of the larger veins and outcrops. The strike length of the veins totalled about 5,500 feet. Many of these at the surface are narrow and not of mineable widths.

The two areas where the ancient miners did most of the mining total 1,380 feet along strike. Using 13.5 cubic feet per ton, this gives about 100 tons per foot of width per foot of depth in these two areas. The widths of the veins are quite variable and the ancient miners took out stopes varying from 1.0 to 4 feet in width near the surface in these areas. If these widths persist with depth, this would give tonnages of from 100 to 400 tons per foot of depth. It is believed that a fair estimate would be 200 tons per foot of depth in these two areas.

Summary

The surface showings of ore at this property are not large and apparently too small to be of economic value. However, it is believed that there is enough tonnage in the area to warrant further exploration. Drilling should be done to determine the persistence, width and grade of the quartz veins at depth.

The areas of alteration and silicification, in which there are small or no outcroppings of quartz, should be drilled or trenched to determine if there are mineable quartz veins below the surface.

It is believed that the grade of ore is better than the samples taken indicate because these samples are from waste, discarded by the ancient miners, or from quartz in the veins which was too low grade to mine.

There is not evidence enough at the present time to prove or disprove the economic value of this property. However, there is enough favorable evidence to warrant diamond drilling and perhaps underground exploration.

Ishmas

The ancient workings at Ishmas were found March 19, 1954, and visited again April 1, 1954. Pits and trenches were put down by a crew of men and samples taken by Shaffner.

Workings were found in two areas about five miles apart. The geology and mineralization are the same so both areas are included in the following description.

Location

The ancient workings are located 80 miles, by road, northeast of the town of Bisha at Lat. 20° 55' N., Long. 43° 20' E. The elevation is 3,000 feet (Aneroid).

Geology

The oldest rocks of the area are sedimentary, mostly shales, sandy shales, and interbeds of limestone. The sediments have been intruded by dikes and sills of diorite and large masses of granite. Most of the sediments are now slates, phyllites and fine grained marbles. Locally, at the contacts of the granites, there are mica shists.

Structure

The sedimentary series is intensely folded and locally highly contorted. The general strike is north to northwest. The dips are vertical or very steep to the west.

The rocks are highly fractured and there are numerous small faults trending in all directions. However, there is a well-defined system of faults which are parallel, or nearly parallel, to the bedding. These faults strike from N. 10° - 45° W. The quartz veins have been emplaced in these fault zones and adjacent fractures.

Ore deposits

These deposits were probably worked at the same time as the other mines in this part of Arabia, about the eighth or ninth centuries B. C.

A detailed estimate of the production was not possible as the old workings are filled with sand and debris but has been not less than 4,000 tons and probably between 6,000 and 10,000 tons. This was not all ore which was milled as there are large waste dumps of barren quartz and country rock. The workings consist mostly of open trenches but in several places the waste dumps indicate there were stopes that went down 20 or 30 feet below the surface.

There are two generations of quartz in the veins. The first, is a white, locally crystalline quartz which was not mined, or if it was broken, was discarded on the waste dumps. The later quartz is a white to gray, dense quartz which contained the gold values and was the ore mined and milled by the ancient miners.

Mineralogy

The ore is a dense, white to gray, gold-bearing quartz with scattered crystals of pyrite. Locally, there are small amounts of hematite, chalcopyrite, sphalerite and galena.

Alteration

The alteration of the adjacent country rock, caused by the emplacement of the quartz veins, is quite intense close to the veins and in most places, the rock is altered several feet from the veins. The altered rock is silicified and locally contains considerable amounts of fine mica, probably hydromuscovite. Small amounts of chlorite are present and a few tiny, needle-like, crystals were found in the limestone which are probably wollastonite.

Alteration of the country rock is more intense and widespread in the southern area than in the northern. Several areas of rather intensely altered sediments were found south and southeast of the northern workings. There are no quartz veins exposed but is is believed that there are quartz veins at depth and the veins did not reach the surface.

Genesis

The sources of the quartz-bearing solutions were probably the granite intrusions which are exposed a few miles to the east. The white crystalline quartz came from the earlier granite intrusions. This is the barren quartz which was not mined, or discarded on the waste dumps. The dense, white to gray quartz which was mined apparently came from the later granite which has been intruded into the sediments and along the contacts of the sediments and earlier granites.

Grade of ore

The samples from the quartz in place all gave very low assays and mostly only a trace of gold. These samples were taken from quartz which was left by the ancient miners and is of the early dense, crystalline variety. This quartz was too low grade to be mined.

The samples from the dumps and sorting areas in the village assayed from 0.01 to 0.51 ounce per ton in gold, and contained traces of silver. The ancient miners apparently sorted the low grade crystalline variety of quartz from the white to gray quartz which contained enough gold to be profitably milled.

Tonnage

There is a large tonnage of quartz available. However, most of the exposed quartz is low grade and of no value. Small veins and stringers of the white to gray quartz were found but all the larger veins have been mined. It would require a considerable amount of trenching and cleaning out the old workings and perhaps drilling before a reliable estimate can be made of the tonnage.

Summary

The assays of the samples indicate that the quartz is of too low grade to be of commercial value. However, most of these samples were taken from the early quartz and not the quartz mined and milled by the ancient miners.

It is believed that there is not enough evidence to prove or disprove the economic possibilities of the district. It is recommended that further geologic work be done to locate areas of alteration where the quartz veins did not reach the surface. To test and sample these areas, trenches and perhaps diamond drilling will be necessary.

It is also recommended that some of the ancient stopes be cleaned out to sample and determine the amounts of both types of quartz in the primary ore.

If the samples indicate ore of commercial grade at depth, or beneath the altered areas, diamond drilling and probably underground exploration would be necessary to determine if there is enough tonnage of sufficient grade to support a mining operation.

Ghu Ksnoon

Old workings and showings of mineralisation were found in some low hills called Ghu Ksnoon. Workings, quartz veins and altered country rock were found over an area of about one square mile.

Location

The hills of Ghu Ksnoon are located 12 to 13 miles south of the town of Haliban at Lat. 23° 15' N., Long. 44° 25' E. The elevation is 2,750 feet (Aneroid).

Geology

The country rock in the area has suffered considerable alteration and fresh specimens could not be found. The rock was probably an andesite or fine grained diorite. There are not many outcrops in the area and the shortage of time did not permit more than an examination of workings and the immediate vicinity.

Structure

The mineralised quartz veins have been emplaced along a major fault zone trending N. 70° - 80° W. and dipping 60° - 65° N. Small quartz veins are also found in the adjacent fractures along this major fault zone.

Ore deposits

History and production

It is not known when the deposits were discovered or worked. There is a small ancient village near the workings but no pottery fragments were found. This place was probably worked during the eighth or ninth centuries B. C., the same time as other mines in Arabia.

The production from the larger workings has probably been not less than 2,500 tons. Most of the workings are filled or partially filled with sand and debris, so an accurate estimate cannot be made. There are about 400 tons of hand-sorted ore and tailings at the old village.

General character

The ore minerals occur in a silicified fault breccia and quartz veins in a major fault zone and the adjacent fractures. Scattered crystals of ore minerals are found in the altered and silicified country rock but all mineable ore is in the veins.

The outcrops of the veins are lenticular but the largest may be traced for 600 feet along strike. The deposits are in fault zones and it is quite likely that they will go to considerable depths. However, drilling would be necessary to prove persistence at depth. Widths of the veins is quite variable. Pillars left in the stopes show widths of 10 to 17 inches but at places, the stopes have been mined to widths of 3 1/2 feet.

Mineralogy

The ore mined is a white to grey quartz containing pyrite, hematite, chalcopyrite, sphalerite, and galena. Small amounts of magnetite, chlorite and serpentine are associated with with ore minerals.

In the weathered portions of the veins, there is limonite with small amounts of chrysocolla, malachite, azurite, and fine, granular chalcocite.

Alteration

The country rock near the veins has suffered considerable hydrothermal alteration and silicification. The alteration has been quite intense and in many places has totally destroyed the original character of the rock. These highly altered rocks are now a mass of sericite, hydromuscovite, some kaolinite, chlorite, fine granular magnetite and limonite. Locally, there is some hematite and serpentine.

Hydrothermal alteration occurred before the intrusion of the quartz which caused the silicification and introduced the ore minerals. In many places near the veins, the alteration minerals have been entirely replaced by quartz. However, it is probable that the alteration and silicification occurred during the same general period.

There are exposures and areas of altered and silicified rock in which there are no quartz veins. Small amounts of ore minerals are present and it is quite likely that beneath these areas there are ore-bearing quartz veins.

Enrichment

There has been a small amount of supergene enrichment in the weathered parts of the veins. However, there has not been enough to materially increase the grade of ore. There has apparently been some enrichment by residual concentration due to weathering.

Genesis

The ore-bearing quartz veins probably come from the same magma as the granite intrusion which is exposed a few miles to the east. However, to prove this would require more detailed work than was possible on this trip.

Grade of ore

Two cut samples from pillars in the stopes averaged 0.03 ounce of gold and 3.59 ounces of silver per ton. These pillars have been left in the narrow and low grade parts of the veins.

Two samples were taken of the quartz on the waste dumps and averaged 0.03 ounce of gold and 1.31 ounces of silver per ton. This quartz had been discarded by the ancient miners and is low grade and not representative of the ore mined.

Summary

The surface exposures of the quartz veins are not large but the areas of altered rock indicate that there are probably veins which do not outcrop. Trenching and probably diamond drilling would be necessary to prospect these areas.

The samples taken are low grade but as these were from pillars and discarded quartz, it is quite likely that ore of better grade was mined.

There is not enough evidence to recommend or condemn the area. However, there is enough favorable evidence to warrant further work.

It is suggested that the ancient stopes be cleaned out and thoroughly sampled. The areas showing intense alteration, but no quartz outcrops, should be trenched and possibly some holes drilled to sample and prove or disprove the presence of ore-bearing quartz.

A thorough reconnaissance of the district should be made for any other exposures of quartz and areas of alteration.

Jebel Ahraybyah

Three miles northwest of the granite hill, Jebel Ahraybyah (lat. 21°00' N., long. 43° 30' E.), there are several outcrops of limonite. When they were found, it was not possible to make even a reconnaissance examination of the area.

Two small outcrops were briefly examined but several more could be seen nearby. It is possible that this limonite is a gossan. There is quartz, carbonate, kaolinite and another clay mineral which is probably allophane, associated with the limonite. The outcrops are so weathered that if this limonite is derived from some other mineral, the original characteristics are almost totally destroyed. However, the remnants of a few limonite pseudomorphs were found. Most of these pseudomorphs are apparently from pyrite but a few exhibit an internal structure which indicates the limonite may have been derived from galena and some from chalcopyrite and chalcocite.

It was not possible to determine the origin of the limonite during this brief examination. Detailed work would be necessary to decide if the limonite has been derived from sulphide ore minerals. There is enough favorable evidence to indicate that this is possible and to warrant further field work.

Jebel Yanoofi

A small outcrop of weathered limonite was found about one mile southeast of Jebel Yanoofi (Lat. 23°30'N., Long. 43°05'E.). Most of the area is covered with sand and gravel and the extent of the deposits is now known. The outcrops are deeply weathered and it was not possible to determine the origin of the limonite. This limonite may be a gossan over a sulphide ore body but trenching would be necessary to secure fresher specimens before this could be determined.

There are intrusions of the late granite in the vicinity and therefore there is a possibility of mineral deposits.

Khurma

The Emir of Zhalm knew of some ancient workings near the town of Khurma and one day, April 5, 1954, was spent in the area.

Location: The workings are located from 10 to 12 miles southeast of the town of Khurma at Lat. 21° 45' N., Long. 41° 55' East. The elevation is between 3100 and 3200 feet (Aneroid).

Geology

The area is largely covered with wadi gravels and sand and there are very few outcrops. The rocks are shales and sandy shales with thin interbeds of sandstone. These sediments are well indurated and locally metamorphosed by dikes and sills of diorite and granite intrusions.

Structure: The sedimentary rocks in the area are highly fractured but no attempt was made to work out the fault patterns during this brief examination. The quartz veins exposed in the area trend from north to northeast and have been emplaced along fault zones and adjacent fractures.

Ore Deposits

The ancient workings in the area are small pits and trenches on the exposures of white quartz. There has been little, if any, production from the area.

Mineralogy: The workings are on white quartz which contains scattered crystals of pyrite and magnetite. Crystals of orthoclase are found locally in the veins.

Alteration: Near the quartz veins the wall rocks are silicified and contain fine grained mica with very sparse chlorite.

Genesis: The quartz in this area is a white, crystalline variety and quite different from the dense, white to gray quartz in the other deposits. The presence of orthoclase indicates that these quartz veins are pegmatites which have come from the nearby granite intrusions.

Grade of Ore: Three samples were taken from the waste dumps and exposures of quartz and assayed from a trace to 0.20 oz. of gold per ton. No silver was present. These samples are too low to be of interest.

Tonnage: Some of the exposures of quartz may be traced for as much as one half mile along strike and as much as 12 feet in width. However, the low grade makes these tonnages of no value.

Summary

The low gold content of the quartz makes these deposits of no value and there is no evidence to indicate that quartz of better grade will be found in the area.

Numahn

The ancient workings in Wadi Numahn were visited February 15, 1954, and several days were spent scouting in the nearby area for any other showings of mineralization. Nothing of interest was found in the vicinity.

Location: The ancient workings are in a tributary to Wadi Numahn about 55 miles, by road, northeast of the Zhalm Mine at Lat. 23° 20' N., Long. 42° 35' E. The elevation is approximately 3200 feet (Aneroid).

Geology

The rocks in the area are sedimentary mostly shales and calcareous shales with some thin, lenticular beds of impure limestone. These rocks have been locally metamorphosed to slates, phyllites and very fine grained marbles by intrusions of granite, andesite, and diorite. Most of the metamorphism has been caused by the intrusion of the granite with local and rather intense metamorphism along the contacts of the dikes and sills of diorite.

Structure: The metamorphosed sediments are intensely folded and fractured. The general strike is about north. The dips are quite variable but the majority are to the west between 70 and 80 degrees.

The rocks are highly fractured but no large faults or well defined fault systems were found in the area. Fracturing is most intense along the bedding planes of the sedimentary series and much of the facturing appears to have occurred before the rocks were metamorphosed.

Ore Deposits

These deposits were probably worked during the eighth or ninth centuries as fragments of pottery were found which have been dated at about this time.

Production from these deposits has been very small and it is estimated that less than 1000 tons of ore and waste have been excavated from the entire workings. The workings consist of open trenches and the waste dumps indicate that the workings did not go down over 10 or 15 feet below the surface. The workings are scattered over an area of about one square mile.

The ore is a dense, white to gray gold-bearing quartz which is found in small veins and stringers in the slates and along the contacts of the slates and limestones and marble. There has been some silicification of the limestones and other sediments but it is not a widespread impregnation and the quartz is usually found in small veins and films in the fractures.

Mineralogy: The ore mined was a dense, gray to white, gold-bearing quartz. Small amounts of pyrite and chalcopyrite are present. Sphalerite and galena are usually found in the gold-bearing quartz veins in this part of Arabia but these minerals were not seen in these deposits.

Alteration: The alteration caused by the emplacement of the quartz is not intense. The wall rocks are locally silicified and small amounts of fine mica and chlorite are present a few inches or at the most a foot or two from the veins.

Genesis: The source of the quartz-bearing solutions was probably the nearby granite. This granite is the older type and not the later granite type which was the source of the mineralizing and quartz bearing solutions at most of the showings of mineralization in this part of Arabia. This is believed to be why the ore is such low grade at these deposits.

Grade of Ore: The grade of ore is very low. Quartz from the waste dumps assayed from 0.02 to 0.05 oz. of gold per ton, which is too low to be of any interest. No decent exposures of veins in place could be found.

Tonnage: The quartz veins in the area are narrow, short and lenticular along strike. No veins of mineable widths or lengths were seen in the area and it is unlikely that any larger or more persistent veins will be found at depth.

Summary

The surface exposures in this area indicate that the deposits are of no economic value. The quartz veins are narrow and not persistent along strike. There is no evidence of widespread impregnation of quartz into the limestone or marble beds. The narrow zones of alteration indicate that it is unlikely any large tonnages of gold-bearing quartz will be found below the surface.

Jebel Ashaila

Five miles northwest of Jebel Ashaila there are shallow ancient workings on outcrops of white quartz veins. These workings are 57 miles by road east of the Zhalm mine at Lat. 22° 40' N., Long. 42° 55' E. The elevation is about 2800 feet (Aneroid).

The quartz veins contain scattered crystals of pyrite but no other sulphide mineralization. The veins are narrow, most only a few inches but some are a foot or two in width. The veins are discontinuous along strike and the greatest length exposed was 160 feet. The general trend of the veins is northwest and the dips are vertical. The country rock is shale with some beds of calcareous and sandy shale.

A composite sample from four outcrops contained a trace of gold. The evidence at the surface indicates that no ore of better grade will be found at depth and it is unlikely that this area will be of any value due to the low grade and narrow, discontinuous veins.

Aduwaha

The ancient workings at Aduwaha were discovered and sampled by D. E. Shaffner. The gold values were quite variable but generally low, too low to be of interest. The property was visited and a reconnaissance made of the surrounding area for other deposits as Shaffner's work was confined to the ancient workings.

Location: The ancient workings are in a range of low hills 100 miles by road, southeast of the Zhalm Mine, at Lat. 22° 20' N., Long. 43° 15' E. The elevation is about 2800 feet (Aneroid).

Geology

The rocks in the vicinity of the deposits are a series of volcanics,mostly flows with some dikes and sills. The rocks are andesites and fine to medium grained diorites. Older sediments which have been intruded by granites are exposed a fewmiles to the south and east.

Structure: The general strike of the volcanics is east and dip to the north. Most of the dips are between 30 and 40 degrees, but in the immediate vicinity of the veins the dips are steep and the structure quite complex.

There are numerous faults of several different ages in the area. However, no attempt was made to work out the detailed pattern except the fault system containing the quartz veins. These faults have a trend of from North to N. 30° W. The dips are generally steep to the west. The quartz veins worked by the ancient miners have been emplaced along these faults zones and nearby fractures.

Ore Deposits

It is not known when the deposits were discovered but fragments of pottery in the village are similar to those which have been dated as eighth and ninth century.

Production from the deposits has been small, at the most, less than 5000 tons. Small stopes, open cuts and pits were all the workings found. These are filled with sand and debris but the waste dumps indicate that they were shallow, probably only 10 to 15 feet below the surface.

Two groups of quartz veins about one mile apart have been worked. Both groups have the same characteristics, small veins and irregular stringers of quartz which have been emplaced along faults and fractures.

Mineralogy: The ore mined from the old workings was a dense, white to light gray gold-bearing quartz. There are scattered crystals of pyrite and small amounts of galena, chalcopyrite and sphalerite in the quartz veins.

Alteration: The rocks in the area have suffered intense alteration. However, the alteration is widespread and has been caused by the intrusion of the larger dikes and sills of diorite. Epidote and sericite with small amounts of chlorite characterize this period of alteration.

The rocks were silicified and fine mica (probably hydromuscorite) formed during the emplacement of the quartz veins. The silicification and fine mica is localized along the quartz veins and in many places penetrates the wall rocks a fewinches or at the most a few feet from the veins.

Genesis: The source of the quartz veins is not known with certainty but probably the quartz bearing solutions came from the late granitic intrusions exposed a few miles to the west.

Grade of Ore: Shaffner sampled the exposed veins and waste dumps so this work was not duplicated. The average grade of the quartz is low and no ore of commercial grade was found.

Summary

The gold-bearing quartz veins are narrow and discontinuous along strike and the narrow zones of alteration at the contacts indicate that it is unlikely that wider veins or better grade of ore will be found. The property does not appear to have any commercial possibilities.

Possibilities of Ore near Adwaha

The area near Adwaha was scouted thoroughly for any other ore deposits. There are veins and masses of white quartz and a number were sampled but no ore of commercial grade was found. The nearest deposits of interest are at Bir Wurshaw, which is described in a separate section.

Bir Wurshaw

The ancient workings at Bir Wurshaw were discovered February 22, 1954. The workings were again visited in March 1954 with Schaffner with a crew of men. Trenches and pits were dug on the old workings and the area thoroughly sampled.

Location: The ancient workings are 125 miles by road southeast of the Zhalm Mine at Lat. 21° 55' N., Long. 43° 25' E. The ancient workings and quartz veins are found over an area of about four square miles.

Geology

The rocks in the vicinity of the deposits are sediments consisting of conglomerate and arkosic sandstone with a few interbeds of sandy shale. The rocks have been indurated and partly metamorphosed. Locally the sediments are silicified and contain epidote and sericite. Along the east and south sides of the area there are intrusions of granite and diorite.

On the west side of the area is a ridge of calcareous rocks, mostly brown, dark gray and light gray limestone, which are locally recrystallized to a very fine grained marble.

The ore in the area is gold-bearing quartz which occurs in veins and irregular stringers which have been intruded into the conglomerate and sandstone. No quartz veins were found in the calcareous rocks.

Structure: The sedimentary rocks in the area have a general strike to the North and the dips are to the West usually between 20 and 30 degrees. However, locally the folding is quite complex, especially in the calcareous rocks.

Faulting in the area is quite complex and there are several different periods. No detailed work was done on the faulting except those associated with the quartz veins. The quartz veins have been intruded into a system of faults which trend north to N. 20° W. Cross-fractures between the larger faults are numerous and some quartz veins have been emplaced along these fractures. The usual trend of these veins is to the northeast.

Ore Deposits

It is not known when the deposits were discovered but were probably worked during the eighth or ninth centuries B.C. when a number of gold mines were operated in Arabia.

The workings are pits, trenches, and open stopes. Most are small and the excavations are down only a few feet below the surface. There are two places where the waste dumps indicate that stopes went down 20 or 30 feet. These stopes are now filled with sand and debris.

The ore is gold-bearing quartz which occurs in veins and small stringers which have been emplaced along faults and fractures. Most of the veins are narrow and lenticular along strike. There is no evidence at the surface to indicate that the veins will be much, if any, wider at depth.

Mineralogy: The ore is a dense white to gray gold-bearing quartz which contains small amounts of pyrite and a few scattered crystals of chalcopyrite and sphalerite.

Alteration: The conglomerates and sandstones are well indurated and locally silicified with some sericite and epidote. This alteration was earlier than the alteration caused by the emplacement of the quartz veins.

Alteration of the country rock near the quartz veins is localized and seldom found over a foot or two from the veins. The country rock is bleached, silicified and contains very fine mica (probably hydromuscovite) and small amounts of chlorite. Small amounts of kaolinite have formed from the feldspars in the granite pebbles in the conglomerate.

Genesis: The sources of the solutions which carried the gold-bearing quartz are the late granite intrusions which are exposed a short distance to the south and east of the area.

Grade of Ore: Six samples were taken when the deposits were discovered. These were from the waste dumps of the old workings and ranged from 0.03 to 0.35 oz. of gold per ton. Only one of these samples 0.27 oz. of gold per ton was from vein in place taken from a small stope. Schaffner put down a number of pits and trenches and sampled the waste dumps more thoroughly. However, the assays of these samples were no higher.

The primary ore in this area is low grade. Apparently the ancient miners worked the weathered portions of the veins where there was some residual concentration of the gold due to weathering but the unweathered, primary ore was too low grade for the ancient miners to work.

Summary

It is unlikely that this area will ever produce ore of economic grade or tonnage. The surface showings of the veins are narrow in width and short along strike. The narrow zones of alteration at the contacts indicate that it is unlikely that the veins will widen at depty. The grade is too low for commercial ore in this country. The sampling has been adequate to give a fair estimate of the grade and it is unlikely that ore of any better grade would be encountered at greater depths.

Um Hadid

The ancient workings at the Um Hadid are also called al Haliaj and were found January 20, 1954. One day was spent examining the workings and taking samples. All the samples were low in gold but contained silver, the highest 15.90 oz. per ton. The high silver assays were of interest so the workings were again visited with Schaffner and a crew of men on January 27, 1954. Pits and trenches were put down and the old workings sampled.

Several days were spent scouting the surrounding area for any other mineralisation. A few small showings were found but nothing large enough to be of interest.

Location: Um Hadid is 172 miles by road southeast of Zhalm Mine at Lat. 22° 20' N., Long. 44° 20' E. The elevation is approximately 2950 feet (Aneroid).

Geology

The rocks in the area are well indurated shales and calcareous shales which have been intruded by diorite dikes and sills. Granite intrusions are exposed about one mile from the deposits but none in the immediate vicinity.

The shales are locally metamorphosed near the contacts of the diorites to sericite schists and slates.

Structure: The structure in the shales is quite complex. Strikes of all directions may be found but the general strike is to the northeast. Dips are quite variable but generally are steep to the southeast or vertical.

The shales are faulted and highly fractured. There have been several periods of faulting but no attempt was made to work out the different patterns except the latest. Most of the quarts veins which were worked by the ancient miners have been emplaced in the fault zones which are irregular but the general trend is about N. 60° 70' E. The dips of these faults are very irregular. Many are vertical but most dip steeply to the west.

Some quartz veins occur along a minor fault system which trends N.50° - 70° W. Most of these faults are vertical or dip steeply to the south.

Ore Deposits

These deposits were probably worked during the eighth or ninth centuries B.C., when gold mining was active in this part of Arabia.

Production from the ancient workings is estimated to have been between 3500 and 5000 tons. Much of this tonnage is waste and is piled beside the ancient workings. The workings are found over an area of about three square miles. Small pits and trenches were found several miles to the southeast but very little work has been done in that area.

Most of the workings are open trenches which are now filled but a few stopes are open and go down 35 or 40 feet below the surface.

Mineralogy: The ore mined was a dense, white to gray gold-bearing quartz. Small amounts of pyrite, chalcopyrite, sphalerite and galena are found in the quartz. Locally there are small concentrations of galena along the contacts of the veins and the wall rock. No silver minerals were found and apparently the silver which is present is in the galena.

Alteration: The alteration of the shales caused by the intrusion of the diorite is quite widespread. Epidote, cholorite, sericite, and some silicification of the shales characterize this early alteration.

The later alteration caused by the quartz veins is much more localized and is seldom found more than a foot or two from the veins. The wall rocks are silicified and contain chlorite, fine mica, probably hydromuscovite, and some kaolinite and allphane has been formed from the feldspars in the diorite.

Genesis: The source of the quartz veins is probably the late granite intrusions which are exposed about one mile west of the deposits.

Grade of Ore: The gold content of the ore is quite low. However, all the samples contained some silver but most were low and not of commercial grade. The highest assay was 15.90 oz. of silver per ton, from a sample of tailings taken from the floor of a hut.

The average grade of the ore is too low in both gold and silver to be of commercial grade.

Tonnage: Most of the veins worked by the ancient miners are narrow, lenticular and may be traced for only short distances along strike. However, three veins have a strike length of from 400 to 1200 feet. These veins are lenticular varying in width from a few inches to four feet but the average width is estimated to be less than one foot.

Evidence on the surface indicates that it is unlikely that the veins will be wider at depth. Drilling would be necessary to prove this but the small tonnage in the surface exposures do not warrant drilling.

Summary

The low gold and silver content of the ore and the small tonnage in the narrow, lenticular veins makes it unlikely that this area will support a mining operation and does not even warrant diamond drilling or further investigations.

Um Matierah Area

There are a number of showings of mineralization and a few ancient mine workings to the west and northwest of Jebel Um Mariarah. The showings of mineralization are found over about 200 square miles but much of the area is covered with wadi gravels and sand dunes.

The ancient miners dug pits and trenches on the outcrops of the white quartz and in the gravels but there are no large or extensive underground workings. There are showings of iron, copper, zinc and sparse lead mineralization but there is no evidence that these were worked, or even prospected, by the ancient miners.

Location: Jebel Um Matierah is 185 miles by road southeast of the Zhalm Mine and 120 miles northeast of the town of Bisha at Lat. 21°18' N., Long, 43°30' E. The elevation of the plain of Wadi Ranya is 2650 feet (Aneroid).

Geology

The oldest rocks in the area are sedimentary mostly shales and sandy shales with some sandstone, conglomerates and lenticular beds of limestone. The sediments have been intruded by dikes, sills, and irregular masses of diorite and olivine diorite. In the northern part of the area and a few miles east there are granite intrusions of two different ages.

The older sediments are well indurated and are locally silicified and epidotized. In the vicinity of the igneous intrusions the rocks are metamorphosed to slates, phyllites, quartzites and fine grained marbles and at the contacts of the intrusions there are mica schists, hornblende schists and small garnets in the marbles.

There is a later gray to white limestone in the area which has been deposited after the folding of the sediments and the intrusion of the older granites and the diorites. This limestone is locally a fine grained crystalline marble but shows no evidence of intense metamorphism, widespread silicification or the introduction of epidote as do the limestone beds in the older sedimentary series.

Much of the area, especially the western part, is covered with recent wadi gravels and sand dunes.

Structure: The general trend of the strikes in the older sedimentary series is N. 10°- 30° W., and the dips are vertical or steep to the west. Near the contacts of the igneous intrusions the sediments are highly contorted and locally the beds are brecciated. The breccia is now healed with introduced quartz and epidote.

The later, gray to white limestone, is generally flat lying or dips at a low angle to the west.

The older sediments and igneous intrusions are highly fractured but only one major system of faults could be found in the area. These faults are parallel, or nearly parallel, to the bedding of the old sediments. There is evidence that there has been movement along these faults at several different times. The solutions which have caused the silicification and epidotization of the older rocks have been introduced along these faults zones. The fault breccia is usually healed with quartz and contains abundant epidote.

Ore Deposits

Gold: There are numerous outcrops of quartz in the area. The ancient miners have dug small pits and trenches on many of the outcrops but there are no extensive workings or any that go down more than a few feet below the surface. Seven samples were taken from the ancient dumps and the quartz outcrops in the area. Six samples showed only a trace of gold and one sample contained 0.02 oz. of gold per ton.

Gold Placers: In several small wadis 6 to 8 miles west of Jebel um Matierah, there are workings in the gravels. The ancient miners worked these gravels as placer deposits and recovered some free gold. Dry panning of the dumps yielded two tiny flakes of gold.

Schaffner dug a number of pits and thoroughly sampled the gravels. The samples were all low grade and none indicated ore of commercial value.

Iron: Several outcrops of massive hematite were found in the central part of the area and also about two miles southwest of Jebel um Matierah. The surface exposures were all found in the older sediments at or very near the contacts of the shale and the interbedded limestone, which is now a fine grained marble. Quartz and epidote occur with the hematite, and the nearby marble and shale are usually silicified. The hematite was introduced by hydrothermal solutions which also carried and deposited the quartz and epidote. There is no evidence that the hematite was formed by the metamorphism and recrystallization of an iron-rich sedimentary rock.

All the outcrops are small and they are not good enough to make an estimate of the tonnage. The hematite occurs in small lenticular masses along the contacts. The individual masses are a foot or two in width and vary from 10 to 50 feet in length. Trenching and drilling would be necessary to determine the size and shape of the individual masses and make an estimate of the tonnage. The evidence at the surface indicates that the deposits are too small to be of economic value and do not warrant any further prospecting.

Some shale beds in the area contain red jaspar and finely disseminated hematite and limonite. The iron content of these shale beds is too low to be of any value.

Copper, Zinc and Lead: Small showings of copper, zinc and lead mineralization were found from two miles west of Jebel um Matierah to Jebel Husiain, a distance of about 14 miles. There are very few outcrops as most of the area is covered with gravel and sand.

The mineralization consists of scattered crystals of chalcopyrite, pyrite, sphalerite and very sparse galena. Most of the outcrops are weathered and there are very few fresh, unaltered sulphide minerals. Limonite pseudomorphs, after the sulphide minerals, and malachite, azurite, chrysocolla, calamine, and smithsonite have been found in the weathered outcrops. There are tiny veinlets of barite in one weathered boulder.

The mineralization is found in the calcareous shales but mostly in the limestone interbeds in the older sedimentary series. The limestone is locally recrystallized to a fine grained marble and is usually silicified. Epidote, cholorite and serpentine are generally present.

Much of the area is covered with sand and gravel but there are enough outcrops and evidence to give the opinion that it is unlikely there is any ore of commercial grade. It is recommended that no further prospecting be done in the area for sulphide mineralization.

Jebel Atahrahd

Four to five miles west of Jebel Atahrahd (Lat. 21°05' N., Long. 43°35' E.) there are a number of outcrops of massive white quartz which contain small amounts of feldspar. The quartz is a pegmatite and is not mineralised except for small amounts of hematite, magnetite and a few scattered crystals of pyrite.

The ancient miners have dug a few shallow pits on the contacts of two of the quartz masses. No mineralization could be found except limonite, hematite and small amounts of magnetite. It is possible that these pits were for iron and not gold or silver.

Jebel Ishatha

Approximately one mile east of the small hill, Jebel Ishatha (Lat. 21°40' N., Long. 43°30' E.) there are several large quartz veins. The quartz is iron-stained and contains limonite, magnetite, and scattered crystals of pyrite. Thin films of chrysocolla were found in a few fractures.

One sample was taken from the outcrops and assayed a trace of gold and no silver. These quartz veins are probably pegmatites, although no feldspar could be found.

Jebel al Fuad

There are large exposures of white quartz three to five miles west of Jebel al Fuad (Lat. 20°50' N., Long. 43°40' E.) The quartz is a pegmatite with small amounts of feldspar. Locally there is hematite and a few scattered crystals of pyrite. A composite sample was taken from three outcrops and assayed a trace of gold and no silver, so is of no value.

A soldier in the employ of the Emir of Khurma said there were ancient workings between Jebel al Fuad and Jebel Eshgahb. This area was scouted but no ancient workings were found. There are outcrops of the massive white quartz but this quartz is not mineralised except for some hematite and a few scattered crystals of pyrite.

Bir Thahen

Several outcrops of white quartz were found four to five miles east of Bir Thahen at Lat. 20°53' N., Long. 44°05' E. The elevation is 2600 feet (Aneroid).

The quartz is massive and appeared to be a pegmatite but no feldspar could be found. There are small amounts of pyrite, hematite and a few scattered granules of chalcopyrite. Samples from two outcrops each contained only a trace of gold and no silver.

The low values and the probability that the quartz is a pegmatitic type makes it unlikely that any ore of commercial grade will be found.

Jebel Rayaniya

On the west side of Jebel Rayaniya (Lat. 20°50' N., Long. 44°10' E.) there are four adits and open cuts. The largest adit goes into the hill seven feet. These workings are on some small quartz stringers. Most of the stringers are less than an inch in width but one averaged four inches over a strike length of 30 feet.

No samples were taken of the showings of quartz due to the small size. There are no indications that veins of mineable widths will be found in the area.

Bir Rayaniya

One mile east of Bir Rayaniya and two miles northeast of Jebel Rayaniya some ancient workings were found May 10, 1954. The workings are shallow trenches and pits on three quartz veins. The workings are not extensive and the dumps indicate that they went down only a few feet below the surface.

The quartz veins contain very little mineralization. Small amounts of pyrite, hematite, and magnetite were found, mostly along the contacts. There are a few scattered granules of chalcopyrite and one small crystal of sphalerite was found.

Three samples were taken. Two cut samples from the quartz veins contained only a trace of gold and no silver. The quartz from the waste dumps near the workings assayed 0.11 oz. of gold per ton, but no silver.

The low grade of the quartz indicates that these veins do not have any economic possibilities.

Jebel Shumruh

There are a number of white quartz veins in the vicinity of Jebel Shumruh (Lat. 22°15'N., Long. 44°20'E.) and southeast for about 20 miles. These veins are in the older sediments and generally found within a mile or two of the granite contact.

Most of the veins are massive white quartz often containing some feldspar and the general appearance indicates that these veins are small pegmatite dikes from the granite. A few of the veins contain scattered crystals of pyrite. Shallow pits and trenches have been dug on these veins by the ancient miners. Samples were taken from the dumps and surface exposures of four of these veins. One sample contained 0.03 oz. of gold per ton and the other three showed only a trace of gold.

The low grade of the samples makes it unlikely that these quartz veins will be of economic value.

Jebel al Gwahmah

Scattered boulders and fragments of weathered hematite were found about one mile east of the small hill called Jebel al Gwahmah at Lat. 22°05'N., Long. 44°35'E. The elevation is about 2850 feet (Aneroid).

No outcrops of hematite were found, only boulders scattered on the surface near the contact of the older sediments and a granite intrusion. This contact was scouted for several miles on each side of the hematite outcrop but no more was found.

The localized occurrence and small amount makes it unlikely that this showing will have any economic possibilities.

Jebel Ashar

There is a small showing of mineralization located seven miles northeast of Um Hadid and about two and one-half miles northwest of Jebel Ashar (Lat. 22°25'N., Long. 44°30'E.). A few shallow pits have been dug on the outcrop by the ancient miners.

The mineralization is in a lenticular quartz vein with a maximum width of two feet. The length is 120 feet. The strike is N. 80° E. and the dip is vertical. Small crystals of pyrite are in the quartz but no other sulphide minerals were found. One sample was taken from the dumps and the exposed vein which contained 0.01 oz. per ton in gold and no silver.

This exposure is too small and too low grade to be of any interest. The adjacent area was scouted but no other showings of mineralization were found in the vicinity.

Obu Salam and Um Mugsuhr

These two groups of ancient workings were found February 6, 1954. One day was spent examining and sampling the dumps and exposures. The workings of Um Mugsuhr are from 3 to 4 miles south of Obu Salam. The geology and mineralization are the same so the description of the two places has been combined.

Location: These ancient workings are located 6 to 8 miles west of the town of Haliban at Lat. 23°30'N., Long. 44°10'E. The elevation is 2650 feet (Aneroid).

Geology

The rocks in the area are sedimentary, mostly shales and sandy shales with a few thin beds of limestone which have been intruded by dikes and sills of fine to medium grained diorite. The sediments have been metamorphosed to slates, phyllites and fine grained marbles. Locally, at the contacts of the diorite, there are sericite schists.

Gold bearing quartz veins have been emplaced along the faults, fractures and locally along the bedding planes of the old sediments.

Structure: The sediments have been intensely folded. The strikes are quite variable but most are between N. 10° - 40° W. The dips are variable but the majority are vertical or steep to the east.

The rocks in the area are highly fractured and there are a number of faults. However, there are no large faults or well defined systems.

Ore Deposits

These deposits ~~were~~ probably worked during the eighth or ninth centuries. Production has been small and the total from both places is estimated to be between 1000 and 1500 tons.

The workings are mostly open trenches and small pits but at the Um Mugsuhr there are two small stopes. These stopes are now filled with sand and debris but the waste dumps indicate they went down 20 or 30 feet below the surface.

The ore is a dense white to gray quartz which is found in small veins and stringers which have been emplaced in the fractures, along the bedding planes of the old sediments and on the contacts of the diorite dikes and sills. The veins are narrow, lenticular and discontinuous along strike.

Mineralogy: The ore is a gold-bearing quartz with scattered crystals of pyrite. Small amounts of sphalerite, chalcopyrite, galena and magnetite were found in the veins.

Alteration: There has been rather intense alteration of the old sediments caused by the intrusion of the diorite dikes and sills. However, this was earlier than the gold-bearing quartz veins. The alteration caused by the quarts bearing solutions is localised and seldom found more than a few feet from the veins. The rocks adjacent to the veins are silicified and contain small amounts of fine mica, probably hydromuscorite, chlorite and serpentine. A few needle-like crystals were found in the adjacent limestones which are believed to be wollastonite but were too small for positive identification.

Genesis: The sources of the quarts bearing solutions were probably the granite intrusions which are exposed a few miles north of the deposits.

Grade of Ore: The grade of the samples taken from the waste dumps and veins in place were between 0.02 and 0.08 oz. of gold per ton. These samples are too low to be of economic value.

As most of the workings are shallow, it is believed that the ancient miners worked the weathered portions of the veins where there had been some residual concentration of the gold due to weathering. Apparently the primary ore was too low grade.

Tonnage: The quartz veins are narrow, seldom more than a few inches in width, but occasionally widen out for short distances to a foot or two. The veins are discontinuous along strike and the longest vein seen in the area is 235 feet in length. The surface exposures indicate that there is not enough tonnage in these deposits to support a mining operation.

Summary

The low grade of ore and narrow, discontinuous veins make it unlikely that these deposits are of economic value. There is no evidence at the surface that the veins will become larger or ore of better grade will be encountered at depth.

Jebel Um Gahra

Several small quartz veins were found near the small hill, Jebel um Gahra (Lat. 24°15'N., Long. 44°40'E.) about 25 miles southeast of the town of Duwadami. The veins contained small amounts of pyrite and chalcopyrite so one composite sample was taken of three veins. This sample assayed a trace of gold and no silver so is too low grade to be of any value.

Wadi al Gawayah

Several exposures of quartz veins were found in Wadi al Gawayah about 15 miles west of the town of al Gawayah (Lat. 24°00'N., Long. 44°55'E.). The quartz veins contain small amounts of pyrite, chalcopyrite and sphalerite. One composite sample was taken from three different veins and it assayed 0.02 oz. of gold per ton and no silver. These values are too low to be of any economic value.

Haliban

Five miles northeast of the town of Haliban (Lat. 23 30 N., Long. 44 15 E.) there are a number of small quartz veins. The quartz is white, massive and shows no mineralization except for a few scattered crystals of pyrite. One composite sample was taken from six veins. This sample contained a trace of gold and no silver.

These quartz veins are probably the barren pegmatitic type, although no feldspar was found. It is unlikely that any ore of economic grade will be found in the area.

Jebel Al Letchathal

There are exposures of a number of quartz veins in a group of low hills called Jebel Al Letchathal. These hills are 14 to 15 miles south of the town of Haliban at Lat. 23°10'N., Long. 44°20'E. The elevation is 2750 feet (Aneroid).

The quartz veins are several feet in width and a number may be traced for 500 to 1200 feet along strike. The veins are made up mostly of massive white quartz with small amounts of feldspar. This quartz is a pegmatitic type and probably came from the older granite intrusions which are exposed to the south and east.

A later, white to gray quartz has been intruded along the edges and in the fractures of the pegmatitic quartz veins. This later quartz contains pyrite, hematite and scattered crystals of chalcopyrite and sphalerite. The amount of this quartz is very small.

The veins did not look encouraging but six samples were taken from six different veins. These samples contained a trace of gold and no silver.

As the bulk of the quartz in the veins is the massive, pegmatitic type and the samples show no values, it is unlikely that ore of economic grade will be found in the area.

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2 - Bogue, Richard G., Report on Geologic Reconnaissance in Northwestern Saudi Arabia 1953 - Unpublished.

Regional Map

To Accompany
Reconnaissance of Mineral Deposits
In a part of

Western Saudi Arabia

RICHARD G. BOGUE
U.S. Geological Survey
U.S.A. Operations Mission
Saudi Arabia 1954

Astral Control: Taken from U.S. Air Force Charts except
AP at Dahlhalat Shabab by R.O. Jackson
Detail Location of Mountains and Mines: Compass Triangulation
by R.G. Bogue

USA OPERATIONS MISSION TO SAUDI ARABIA
American Embassy - Jidda

June 1, 1954

MEMORANDUM

TO : Mr. Harland J. Corson, Director
USA Operations Mission to Saudi Arabia

FROM : Glen F. Brown, Chief
Natural Resources Division GB.

SUBJECT: Monthly Report - May 1954

Reconnaissance mapping of geology and geography continued during the month. Arrangements were made with the Arabian American Oil Company to prepare a joint geologic map of the peninsula in accordance with the Finance Minister's order of October 25, 1953, and work on the compilation was started during the month. A map on a scale of 1 - 4,000,000 will be presented within a few weeks, followed by sheets prepared on a scale of 1 - 500,000.

GFBrown:mep

USA OPERATIONS MISSION TO SAUDI ARABIA
American Embassy - Jidda

April ~~26~~ 25, 1954

MEMORANDUM

TO: Mr. Harland J. Corson, Director
USA Operations Mission to Saudi Arabia

FROM: Glen F. Brown, Chief
Natural Resources Division

SUBJECT: Monthly Report - April 1954

Reconnaissance mapping of geology and geography continued during the month. Work was continued on gold-bearing quartz veins found northeast of Bisha, on old workings in the vicinity of Khurma, and in the mountains between Qhama and Wadi Ahsaba within the Quinfida-Lith block. Of immediate interest in this region was the discovery of a possible roadway from Lith to the Qizan basin near the foot of the Asir scarp. This region, which is mostly unexplored, is densely populated with numerous villages and large areas of cultivation. Wadis Hali, Raish, Gashar, Jabola, Ghat, and Yiba were found to be perennial streams for many kilometers along their upper courses. A lead-bearing vein system in marble and an outcrop of copper-bearing sulphides were found during the reconnaissance.

The field work on the laterite beds in the Sirat of the Asir was completed during the month and a small iron deposit was examined on top of Jebel Suda, west of Abha. Samples of the laterite were crushed and split; fractions were sent to Washington for analysis. A map based on aerial photographs and showing the laterite beds was nearly complete at the end of the month.

GFBrown:mep

UNITED STATES OF AMERICA
~~TECHNICAL COOPERATION ADMINISTRATION~~
USA OPERATIONS MISSION TO SAUDI ARABIA
American Embassy - Jidda

February 28, 1954

MEMORANDUM

TO: Harland J. Corson, Director
USA Operations Mission to Saudi Arabia

FROM: Glen F. Brown, Chief
Natural Resources Division
Glen Brown

SUBJECT: Monthly Progress Report - February 1954

During the month the drilling contractor completed two wells at the two wadis on the south side of Khulais. One well found salt water in sands of Eocene age thereby precluding the Eocene sandstone as an aquifer except under very special geologic conditions. The other well is in fresh water and the driller reports that he was unable to lower the water level below 45 feet beneath the surface of the land with his bailer. The gravel extended down to a depth of 85 feet and the water level stands at 20 feet, giving 65 feet of fresh-water saturated gravel suitable for drinking or irrigation purposes.

Calculations for the astronomical positions to prepare photo maps of the Yenbo block were completed during the month. Some map compilation on the Lith-Qunfida blocks was also accomplished.

Geologic field work to assist Mr. Dan Shafner, Mining Adviser, in the vicinity of Dhalm continued during the month.

Field work began on sampling of the laterite deposits in the Asir.

A trip for the Ministry of Communications was completed during the month. Reconnaissance in company with communications engineers was made from Medina northward along the abandoned Hejaz railroad to determine feasibility of rehabilitation. Geologic and water supply conditions were observed and samples of water were collected for chemical analysis. A brief report was prepared for the joint committee, a copy of which is attached.

The drilling contract expired at the end of the month and all rigs were at Riyadh and in the drilling compound at Jidda except two rigs, a Joy 150 rotary and a Star 72 spudder, which were at Khulais and near Sabya in the southern Tihama. American personnel were preparing for return to the United States at the end of the month. There will be no additional drilling activities reported unless an agreement is made with the Saudi Arabian Government and a contract is let with a firm to drill under the technical direction of the Natural Resources Division.

ADDENDUM TO MONTHLY PROGRESS REPORT - FEBRUARY 1954:

The production well at Khulais was down 20 feet at the end of the month and it was decided on the last day of the month to continue the contract for 30 days to finish this well, test two wells at Itwad, and try to complete a production well at Itwad during March.

Geological Reconnaissance from Medina to Ma'an Along the Abandoned Hejaz Railroad

Eleven wells were noted along the route and samples of water were collected for analysis. Pumps could be installed easily in them, the depth to water ranging from three to 72 feet beneath the surface of the land.

Water in the hard crystalline rocks south of Al'Ula is scarce, and water for the railroad must come from alluvial gravels in Wadi Hamdh and tributary wadis. The large supplies lie in lower sections of the sandstone at Al'Ula and northward. Artesian water at Tebuk has possibilities for agricultural development.

In addition to water, fragments of an iron-bearing formation, a limestone series, and sedimentary beds of an age comparable to the phosphate beds in Trans-Jordan were seen. Studies of these formations may justify development of materials to be hauled on the proposed railroad.

Glen Brown

Glen F. Brown, Chief
Natural Resources Division

February 28, 1954

7

USA OPERATIONS MISSION TO SAUDI ARABIA
American Embassy - Jidda

February 28, 1954

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Glen F. Brown, Chief
Natural Resources Division

February 28, 1954

To TCA/w
1/3/53

Natural Resources: I hope you have been successful in clarifying the relations between TCA and the Geological Survey. I believe that until this is accomplished, increasing difficulties will be encountered in the field in planning and carrying out a coordinated TCA program.

~~M B-1 519~~

File

N.R.

April 21, 1953

To: All Members TCA Staff

From: TCA/M - H.P. Martin, Assistant Administrator for Management

Subject: Statement of Relationships Between the Department of the Interior and the Department of State (Technical Cooperation Administration)

Attached hereto, for your information and guidance is a copy of the captioned statement of relationship which sets forth the principles governing the relations between TCA and the Department of the Interior.

POINT 4 RELATIONSHIP BETWEEN THE DEPARTMENT OF THE INTERIOR AND THE DEPARTMENT OF STATE (TECHNICAL COOPERATION ADMINISTRATION)

Pursuant to the Act for International Development, the President by Executive Order No. 10159, issued September 8, 1950, authorized and directed the Secretary of State, with certain exceptions, to exercise the powers vested in the President by the Act. The President also authorized and directed other agencies of the Government upon the request of the Secretary of State, to participate in the carrying out of the purposes of the Act and the Secretary of State in cooperation with the heads of such agencies, to plan and execute the programs authorized by the Act.

The Department of State in Departmental Announcement 212, issued on October 27, 1950, announced the establishment of the Technical Cooperation Administration (TCA) as an integral component of the Department, and stated that the Technical Cooperation Administrator will, under the general direction of the Secretary of State, plan, implement, and manage the Point 4 programs as authorized by the act.

The responsibilities placed in the Secretary of State by the President under the Act thus call for the closest mutual cooperation and support between the Department of State (TCA) and the technical agencies of the Government in order to achieve the objectives of the Act. The technical agencies of the Government which are requested to participate in the program will, under the leadership of the Department of State, cooperate in the spirit of a partnership for the purpose of achieving common objectives in the tasks which they are requested to perform.

The form and extent of the participation in the program by a technical agency of the Government will be governed to a large extent by its effectiveness and economy in carrying out the objectives of the Act, and the available facilities of such an agency.

While realizing that the opportunities for perfecting the relationship between the Department of State and the other agencies of the Government participating in the Point 4 program will materialize as they work together in advancing the program, it is deemed desirable to set down the broad principles governing the relations between the Department of State and the Department of the Interior. The principles herein set forth will be subject to modification from time to time as future developments of the program and other circumstances may require. All references to the Department of the Interior in this paper shall be understood to include the constituent Bureaus and Offices of that Department.

(1) Maximum use will be made of the skills, knowledge, experience, contacts and resources of the Department of the Interior which have been developed over a period of many years both in the United States and elsewhere. To this end TCA will consult with the Department of the Interior in all phases of the program planning and execution of the Point 4 program pertaining to its fields of specialized competence. In conjunction with the other technical agencies of the Government, the Department of the Interior will participate, under the leadership of TCA, in the development and refinement of country programs based upon the needs of each country.

(2) TCA will have overall responsibility for the development, approval and execution of all aspects of technical cooperation for each country in which it has a program under the Act for International Development. The Department of the Interior will provide technical guidance and technical servicing to the country mission in its fields of specialized competence. In addition, the Department of the Interior will undertake such specific projects or segments of a program in its fields of competence as are mutually agreed upon between TCA and the Department of the Interior.

(3) Country programs will be initiated and developed in so far as practicable by the TCA missions in the field in collaboration with the appropriate ministries and agencies of the host government. It is understood, however, that the Department of the Interior or its field specialists may suggest or be requested to provide

proposals for consideration by the Country Director in the development of country programs. Such programs will be reviewed in Washington and approved by TCA, after consultation with the Department of the Interior for those segments of the programs which fall within its fields of specialized competence. The Department of the Interior will carry out those portions of programs that fall within its fields of competence upon the conclusion of mutually accepted activity authorizations which include a statement setting forth the nature and scope of the Department's participation. Programs for training in the United States will be developed as an integral part of the country programs.

(4) In order to assure that the Point 4 program in each country is well integrated and coordinated, TCA will appoint in each country a Director of Technical Cooperation who will, under the general supervision of the Chief of Diplomatic Mission, be in charge of Point 4 operations in that country. All employees and officers of all U.S. departments and agencies assigned to the Point 4 program will work under the general direction and supervision of the Director of Technical Cooperation, and will be considered part of his staff. They will thus be part of one United States mission, and will not constitute several separate missions for various U.S. agencies. The Director of Technical Cooperation will keep the Department of the Interior informed of work progress, major problems concerning programs and agency personnel, technical backstopping required for the programs or as requested by agency technicians, and will provide agency technicians effective administrative support and sufficient latitude to permit successful execution of the work.

(5) The Director of Technical Cooperation will have a general staff to assist him in connection with overall program development and administration, which staff will vary in size with the country and the program.

(6) In general, technical personnel, including the chief technician, if any, in the fields of development of water resources including irrigation and power, other sources of energy, mineral resources, mining, topographic mapping, fisheries, and land management, will, subject to the right of approval of TCA, be recruited and employed by the Department of the Interior, provided that the Department of State at all times reserves the right to recruit and employ technical personnel in any of these fields of activity after consulting with the Department of the Interior. The Department of the Interior is expected to retain responsibility for the personnel administration of its employees assigned to the Point 4 program subject to the personnel policies and standards established by TCA.

(7) In order to reduce the cost of administrative services, such as the payment of salaries, allowances and travel expenses, in Washington and to provide effective and well integrated administrative support for Point 4 operations in the field, administrative services shall be provided by the field missions of the Department of State to the greatest extent practicable.

(8) A system will be established for regular reports on all Point 4 activities to be made to the Department of State by the Director of Technical Cooperation, with information copies being furnished to the Department of the Interior. Technical personnel and the Department of the Interior will communicate directly on technical matters, with information copies being furnished to the Director of Technical Cooperation and to the Department of State.

(9) All travel arrangements for Point 4 personnel going abroad will be made pursuant to procedures established by TCA, in consultation with the technical agencies, and all foreign field trips to be made by Washington personnel out of Point 4 funds will be subject to the prior approval of TCA.

(10) TCA will provide general indoctrination and orientation for all Point 4 personnel going into the field. The Department of the Interior will provide technical orientation for any such personnel who will be engaged in its fields of specialized competence.

(11) The Directors

(11) The Directors of Technical Cooperation will consult with the Department of the Interior from time to time either prior to the commencement of their assignment abroad or on the occasions when they return to Washington for consultation.

(12) The Department of the Interior will, from time to time advise TCA as to whether specific projects in its fields of specialized competence can best be performed by contract with a private organization. If it is determined that such a contract is to be entered into, the Department of the Interior will recommend competent contractors and TCA, with the technical advice and cooperation of the Department of the Interior, will negotiate and execute a contract for each such project, a copy of which will be submitted to the Department of the Interior. Within specific projects TCA may authorize the Department of the Interior to negotiate in its own name, one or more contracts for the performance of certain aspects of the project. Any such contract will be subject to the terms of the activity authorization and to such approval by TCA as is specified therein. In the case of training, contracts may be made by the Department of the Interior subject to the prior approval of TCA.

(13) Training in the United States of foreign nationals nominated by the Directors of Technical Cooperation will be provided under the direction of the technical agencies of the Government pursuant to procedures established by TCA. Nominations for training by the Department of the Interior will be submitted to the Department of the Interior for determination of acceptability and normally shall be based upon prior consultation between the Directors of Technical Cooperation and the Department of the Interior or its field technicians. Training programs for accepted trainees and other visitors in the fields of specialized competence of the Department of the Interior will, in general, be planned and carried out by the Department of the Interior on the basis of background information supplied by TCA and subject to its approval.

(14) The Department of State will allocate to the Department of the Interior from available funds, such amounts as may be necessary to fulfill the responsibilities of the Department of the Interior in the United States and to execute in the field the responsibilities assigned to it under specific activity authorizations.

February 25, 1953

(1)

UNITED STATES OF AMERICA
OPERATIONS MISSION TO SAUDI ARABIA
POINT 4

American Embassy
Jidda, Saudi Arabia
July 3, 1954

MEMORANDUM

TO : Mr. Harland J. Corson, Director
USA Operations Mission to Saudi Arabia

FROM : Glen F. Brown, Chief
Natural Resources Division Glen Brown

SUBJECT: Monthly Report - June 1954

Preparation of reports occupied most of the time of the field party during the month. Field work consisted of completion of the astral control for the last of the aerial photography. The geography on 16 sheets of the Quanfida-Lith block was finished and transmitted to Washington for printing. Seven sheets remain in the vicinity of Lith. Field work, including sampling, on a low-grade copper deposit in the northern Hejaz was completed and a report for the Finance Minister was nearly complete at the end of the month. Twenty-one water analyses were made including ten samples from the abandoned railroad between Medina and the Jordan border.

Samples for petrographic and paleontologic studies were prepared and shipped to the Geological Survey in Washington. Rough draft describing 13 localities where the ancient people mined were also prepared during the month.

NR Rpts ②

Geologic studies by American geologists of U.S. Geological Survey field party working under the auspices of the Point Four Program and in cooperation with the Mining Advisor to the Saudi Arabian Government have investigated a low grade copper deposit in the vicinity of Mahad Dahab, Hejas Saudi Arabia.

The copper was found in numerous shear zones in the pre-Cambrian chlorite schists. Sampling of slag, old dumps and accessible ancient working in an area of approximately two square kilometers indicate that 120,000 ~~163,000~~ tons of copper ore averaging 1.35% copper and 113,000 ~~[illegible]~~ tons of ore averaging 0.57% copper are readily accessible for mining in the outcrops. In addition, 110,000 tons of broken slag averaging 1.06% copper and 12,000 tons of tailings averaging 2% copper are available on the surface.

Another area of possible interest lies in the Eastern Nejd near Duwadami. Ancient dumps which assay several ounces of silver are readily accessible over an area of several square kilometers. Extensive mineralization of igneous contacts suggest that worthwhile mineral deposits may be found.

Jidda, Saudi Arabia
July 3, 1954

(Drafted by Gus Goudarzi for Glen Brown.)

FILE

Jidda, Saudi Arabia

July 29, 1952.

MEMORANDUM TO: Sadek Bey Husseini

FROM: Mr. Edward Betaig

RE: Historical Summary of Technical Cooperation Administration in Saudi Arabia

The attached is an historical summary of the Technical Cooperation Administration in Saudi Arabia, from its beginning with the Natural Resources Field Party program and extending through to the present time.

It makes no pretense of being a detailed account but shows the definite progress that has been made in a relatively short time toward carrying out the objectives of Point 4 as planned and sought both by the governments of Saudi Arabia and of the United States.

If required by you, additional details will gladly be furnished. I trust that this will meet with your satisfaction.

Edward Betaig
Assistant Program Officer

EB/1
Attachment

ORGANIZATION. SA - Historical Summary of TCA in SA.

July 26, 1952.

HISTORICAL SUMMARY OF POINT 4 PROGRAM IN SAUDI ARABIA

The Technical Cooperation Administration mission to Saudi Arabia has a history of less than two years, yet in that time much basic work has been accomplished. Originally composed of two groups in the fields of Natural Resources, and Public Administration and Government Services, the program is in the process of being expanded under the direction of Dr. Samuel S. Stratton, U. S. Director of Technical Cooperation in Saudi Arabia, working in close cooperation with His Excellency Raymond A. Hare, U. S. Ambassador to Saudi Arabia. Dr. Stratton became the first country director for the new unified program. Previous to his arrival in March, 1952, Dr. Arthur N. Young, Chief of the Public Administration and Government Services Mission, was the Acting Director for several months.

Under the terms of the General Agreement of January 17, 1951, the Saudi Arabian Government has requested the aid of the United States in implementing an enlarged program for Fiscal Year 1953. It is intended that the work of the Natural Resources and the Public Administration and Government Services groups be continued while developing new programs in public health, agriculture, education, transportation and communication, and aerial mapping.

On March 16, 1952, the Saudi Arabian Government requested the expansion of the program and on April 28, 1952, the representatives of the American Embassy replied accepting the request in principle. Negotiations are being carried on with His Majesty the King and the Royal Ministries in order to work out the concrete project agreements necessary to carry out various proposals. Dr. Stratton is engaged in talks with the various Saudi Arabian Government officials concerning a proposed mineral resources survey, a railroad survey, a public health program, agriculture projects, an education program, and aerial mapping and photography.

Currently, the TCA mission is composed of 14 persons. Dr. Samuel S. Stratton is the U. S. Director of Technical Cooperation in Saudi Arabia and is responsible for the direction of the program. On his staff are Mr. Edward Betzig responsible for programming and administrative duties, and Miss Laveone Swearingen and Mrs. Diana George, secretaries. The TCA mission has three field parties

(Continued)

responsible to Dr. Stratton. The Natural Resources Field Party is composed of Dr. Glen Brown, Chief, and technicians Roy Jackson and Donald Dougherty. The Public Administration and Government Services Field Party is made up of Dr. Arthur N. Young, Chief, technicians John Dunaway, Robert Kennedy, and John Stacy, and secretaries Mrs. Edna Stacy and Mrs. Louise Nelson. The Education Field Party is made up of Dr. Thomas Fisher, Acting Chief. In the near future, additional personnel will be added to Dr. Stratton's staff, and also Field Chiefs in Agriculture, Public Health, and Transportation and Communication are expected to arrive.

Coordination and liaison duties between the U. S. mission and the Royal Ministries of the Saudi Arabian Government are carried on through the office of Sadek Bey Husseini and his staff. In this way a well integrated and effective program is being organised.

The Point 4 Program in Saudi Arabia is in the process of being enlarged. Conferences have been held between officials of the Royal Ministries and Ambassador Hare and Dr. Stratton concerning the making of a railroad survey which will determine the exact route for the proposed Riyadh-Jidda Railroad. This survey will be the largest project undertaken so far by the two governments under Point 4 and promises to be of great importance in furthering Saudi Arabian development. It will be carried out by a U. S. engineering firm under TCA auspices and depending upon the circumstances should be completed in 6 to 8 months. It is hoped that this will only be the beginning of the laying out of a modern network of transportation and communication facilities. It will be the function of the Chief of this field party to coordinate and draw up such plans. As a possible project in the future, there is the planning of a number of roads connecting the Asir to the Hejaz thus facilitating the movement of produce from the Asir and hence aiding the growth and improvement of agriculture in that area.

Programs in agriculture and public health will also get underway in the coming months. Programsof this type of necessity need time before having an impact on a country.

(Continued)

HISTORICAL SUMMARY July 26, 1952.

NATURAL RESOURCES FIELD PARTY

As a result of conversations between officials of the Government of Saudi Arabia and of the United States of America including the U. S. Geological Survey officials and Mr. George McGhee, then the Assistant Secretary of State, Mr. Arthur Z. Gardiner and the former Ambassador to Saudi Arabia, Mr. J. Reeves Childs, a USGS Ground Water-Minerals mission was organized under Public Law 402, Title 1, Section 2, for field work in Saudi Arabia.

Glen Brown was appointed Chief of the Field Party in December, 1940. Representatives of the Department of State, the Food and Agricultural Organization of the U. S., and the Bureau of Reclamation of the Department of Interior drew up a plan to reconnoiter western Arabia; study potential sources of water, metallic and non-metallic mineral deposits and other natural resources; prepare basic maps and advise the SAG on water supply and geological problems. This work was to supplement that done by the Arabian American Oil Company in their concession in eastern Arabia. The plan was to concentrate on western areas outside of this concession and also on the south - western Asir-Tihama country1 In great part unexplored and extremely rugged, these southern lands offer fair water and land use possibilities.

Shortly after arriving in Saudi Arabia, because of the water shortage at Riyadh, capital of the Kingdom, the field party of Glen Brown and Roy Jackson began work in that area. After exploratory studies had been carried out and conferences held with Aramco geologists, a test drilling operation was begun. Drilling brought in water from a buried Pleistocene channel in Wadi Hanifa near Riyadh and it became the city's principle source of water.

Field work was begun in Asir al Tihama in January 1951 and continued during the winter and spring of 51-52, with emphasis on studying the potential water supply, doing basic geological field work and mapping the region. Aerial photos were taken by an aerial photography firm and sent to Washington, D. C., in order to make up the final map. On the basis of this study, it will be possible to give details regarding the ground water situation and the geology of the region and also to outline a test drilling program for increasing the water supply. It is to be noted that the climate of Saudi Arabia is among the severest in the world. Due to the extreme heat, and wind and sand storms of the summer, the field season runs from about November 1 to April or May 1. While the Asir has definite possibilities for development, the lack of scientific knowledge of its geology, geography, water and soil, etc., make plans for development premature until such information has been worked up.

Exploration

Exploration and mapping in this section are carried on under arduous conditions. Populated centers are scattered, and communications elementary. The terrain presents many difficulties in the use of automotive equipment necessitating much travel by donkey and camel.

This rugged and difficult region was studied in two sections. The first section runs along the western edge of the Empty Quarter north from the Yemen border to the Emirate at Wadi Tathlith 80 miles south of Bisha including the Wadis Najran, Habanna, Qatan, Alyan, Talham, Ghuwairba, Es Shara, Idima and Tathlith.

Further exploration was conducted in a second strip running from the top of the range at Dhahran al Yemen south to the Yemen border at Alb pass. The party traveled for two weeks by camel and donkey and proceeded north from Alb Pass along the rim of the Asir to the headwaters of Wadi Qa'a via Khashaba. Exploration was carried into the area of Baish, Wadi Farsha and then to the top of the 7500 feet escarpment for astral observations and mapping. Approximately 20,000 square miles were mapped, this being the area also covered by aerial photographs. Due to the fact that the region has not been the scene of much scientific study, the current exploration resulted in the development of accurate knowledge of the geology, geography and drainage of the area.

Besides this work of mapping and field study, the drilling program goes along space. In all the regions where water resources work is being done, basic field study and mapping must be carried on before consideration and the planning of experimental farms, irrigation and reclamation works, and even railroads, highways and mines can be undertaken. This necessitates careful and arduous exploration and mapping and cannot be done quickly. Such work may not seem spectacular but it is one of the prime supports upon which to build an intelligent and long range program of Saudi Arabian economic development.

Test holes are being drilled in the Wadi Fatima, Hada Sham, Wadi Kulais and Usfan sections. The study for Taif, the summer capital, required exploration, aerial photographs and topography maps of about 1200 square miles. Test drilling has begun in this region.

On the coastal

HISTORICAL SUMMARY

July 26, 1952.

On the coastal plain at Al Tihama, field work has been carried out to provide for test drilling holes for the water supply of the city of Qizan. Studies of the water supply situation and recommendations have been made at Yenbo, Rabigh, Buraida, Afif, the mining properties of Dhahrn and Jifan Gramba (Dalm) and the city of Jidda. Currently, Yenbo and other locations are being test drilled.

Jidda, a rapidly growing city, has a demand for water that grows constantly. Current flow is about 700,000 gallons daily. With larger piping, these sources have a rough potential of 2 to 3,000,000 gallons daily and should be sufficient for minimum present and near-future needs if used carefully.

Two programs - one emergency and the other long run - are being worked on at Riyadh in the Ha'ir, or Hayyir, district. The need exists for rational long-range plan of water use. The water sources discovered recently would seem to be sufficient for the city, and work needs to be done in building check dams and testing of the Ha'ir installations of the pipeline which is being constructed by a contracting firm.

In addition to mapping the geology and geography in the reconnaissance mapping, the mission has made many astronomical observations for mapping control, several hundred altimeter elevations and water analyses.

With the arrival of Mr. Dougherty, senior hydraulic engineer, in March, 1952, the Field Party has a highly qualified hydraulic engineer to supplement the work done on water resources and economic geology by Glen Brown and Roy Jackson and to make studies of desert floods and other surface water problems.

In order to accomplish practical results from the mission's work, a drilling program with Michael Baker, Jr., Inc., doing the drilling and under the general direction of the Chief of the Natural Resources Field Party of TCA is being started. This project will require a large amount of equipment and represents a big investment on the part of the Saudi Arabian Government. The fact that no wells will be dug until Dr. Brown has been consulted and given his approval will aid considerably in the development of a planned water use program.

It is intended

It is intended to enlarge the field party by the addition of two geologists. Much basic work is yet to be done before even a partial inventory can be compiled of the water and other natural resources of Saudi Arabia. This great land has remained up to today as one of the least studied sections of the world. Now, with the large sums of oil money available, it is possible to exploit hitherto unused resources. These have remained undisturbed up to the present time due to the lack of knowledge of their potential, the isolation of the country and insufficient capital necessary to develop them. The oil wealth means that Saudi Arabian cities and populated areas will grow in size, making for increased demands for water and food stuffs. Population growth will also mean a larger market and greater demand for goods. Hence, need exists to expand and diversify the economy and to open up and develop new resources and industries. The work of the Natural Resources Field Party can only be fully judged if viewed from this long-range view. Its immediate value may be seen in its providing the knowledge necessary for the location and drilling of water wells and the planning of agriculture and irrigation development projects.

Such field work and study have ensured the rational use of the resources of all developed countries. Taking into consideration the vast size of Saudi Arabia; the severe climatic conditions at certain seasons of the year; the isolated nature of its populated centers; the lack of any kind of interlocking transportation and communication network, and the rugged nature of terrain features, much time is needed to provide the required information.

The Point 4 mission has made a sound beginning and as its work continues will give the basis for the long-range, scientific growth and use of potential resources. The excellent cooperation and help of the officials of the Saudi Arabian Government have gone a long ways towards ensuring its success.

PUBLIC ADMINISTRATION

HISTORICAL SUMMARY

July 26, 1952.

PUBLIC ADMINISTRATION AND GOVERNMENT SERVICES FIELD PARTY

Following extensive negotiations between the American Embassy and Saudi Arabian officials, Arthur N. Young was chosen to act as Chief of this TCA field party in April, 1951. He arrived in Jidda on July 12, 1951, to be followed by Robert B. Kennedy, Tariff Expert on September 20, 1951; John A. Dunaway, Customs Advisor Expert on February 8, 1952; and John A. Stacy, Budget Expert on February 19, 1952. For several months prior to the arrival of Dr. Samuel S. Stratton, Dr. Young served as Acting Director for TCA in Saudi Arabia.

In cooperation with Ambassador Hare, the mission worked with the Minister of Finance and other government officials. It studies centered in the port of Jidda, the chief financial city and the center of foreign trade. This city is an action center for the Minister of Finance and other government ministries and departments.

An important aspect of the mission has been to advise the SAG on financial problems as they arise. As a result of nearly a year of work, very definite achievements may be noted; de facto stabilization of riyal (the silver coin of Saudi Arabia); future issuance of new gold sovereigns with stable value in dollars; helping to regularize payments to public employees; beginning the liquidization of the over-draft to the Banque de l'Indochine and the Netherlands Trading Society; studying and improving customs; writing a new tariff law and tariff schedule; studying the budget and suggesting improvements in consultation with the Minister of Finance on drafting the budget; creating a Monetary Agency; and also seeking the governmental creation of various type reserves and funds for economic development purposes.

PUBLIC FINANCE

As the Finance Minister showed interest in the creation of a government Monetary Agency, a report was submitted November 14, 1951, recommending the creation of an agency to act as fiscal agent, to handle currency matters and conduct economic research. Following a series of talks, a royal decree and a charter were drawn up and signed on April 20, 1952, establishing the "Saudi Arabian Monetary Agency" with an authorized capital of 6,000,000 dollars. Mr. G. A. Blowers of the International Monetary Fund has been appointed by the Saudi Arabian Government to organize and operate the Agency.

In the

In the course of discussions with the Minister of Finance, it was also recommended by Dr. Young that the new standard for Saudi Arabia be a gold standard based on the new gold sovereign which should be linked to the American dollar.

BUDGET

The mission, being represented in this field by John A. Stacy, sought to collect data relative to the government budget system and to the budget for the coming year (SAG fiscal). At the request of the Assistant Deputy Minister of Finance and the Director General of Finance, a report containing recommendations for the proposed budget were made. It is desired to keep the budget elastic and direct surplus revenue into the economic development program and currency reserves. The suggestions were reviewed by the SAG officials for consideration. A draft is in the process of preparation for proposals looking toward reform of SAG budgetary organization.

CUSTOMS

In the customs field, the mission has made a thorough study of the actual operations as well as the basic custom legislation and regulations, as a basis for recommendations for improvement. John A. Dunaway and Robert B. Kennedy have been making a joint study of the whole customs field, observing operations of the port of Jidda in all phases of the procedure of clearing goods. Many apparent defects in procedure and operation have been found; the accounting system is inadequate, statistics in foreign trade are lacking. The mission is studying and presenting ideas as to the type of duty basis of valuation and the type of tariff nomenclature best suited to Saudi Arabia. The proper levels of duty for Saudi Arabia are being sought. This work is necessarily slow and detailed. A new tariff law is being drawn up and a new schedule of tariff dties and rates is being proposed. This is a big and important job and cannot be done hurriedly.

The modernization and reform of governmental administration and financial procedures require time. Documents must be translated and studied; countless interviews with officials held; procedures and practices observed and also the historical and current stage of development understood before changes that will prove permanent can be recommended. This mission in working in areas outlined above cannot but have its impact on the development of this nation.

EDUCATION

EDUCATION

In this field chief importance is given to the improvement and organization of commercial and vocational schools. In Jidda a commercial school sponsored jointly by TCA and a group of local businessmen has been approved by the Saudi Arabian Government. Equipment for the school has been purchased, a locale chosen for its operation, and a teaching staff is being selected. It will open in September and will offer courses in business and commercial subjects. Its graduates will in part satisfy the need for trained personnel for the many business houses in this growing city. Plans are underway to modernize the equipment of the local vocational school. It is hoped that commercial and vocational schools will be established in other cities in the country under Point 4 auspices. In this way, the Education Field Party will aid Saudi Arabia by training youth for positions in industry and commerce.

NR Rpts

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

December 31, 1953

MEMORANDUM

TO: Dr. Glen F. Brown
Chief, Natural Resources Division

FROM: Harland J. Corson, Director
USA Operations Mission to Saudi Arabia

SUBJECT: Reports

I have just received a letter from our Washington Office in which they request that you prepare the following:

1. A comprehensive report of all work accomplished to the present in Saudi Arabia by the Natural Resources Division.

2. A detailed plan of work of your Division for the remainder of FY 1954.

3. An overall plan of work for the proposed $2,000,000 water development program under Economic Aid, including in such plan of work the information listed in the second paragraph of my cable to Paul Taggart dated December 17th last, sent from Istanbul after consultation there with Malcolm Jones.

I believe you have a copy of the above-mentioned cable in your files.

I will appreciate your letting me have such reports at your earliest convenience so that I can forward them on to Washington. If I can be of help to you in the preparation of these, please let me know.

HJCorson:o

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Info Copy: — Taylor ③
NR — Rpt file

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CONFIDENTIAL JANUARY 210847

Corson letter December 31.

Submit soonest Brown report USOM Activities and over-all work plan economic aid water development program.

PAND

lms

DIST:

Ambassador
FOA - Action — Corson
McCullars
File

CONFIDENTIAL

NR Rpt

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

January 19, 1954

Mr. T. E. Eakin,
Water Resources Division,
U.S. Geological Survey,
Washington, D. C.

Dear Tom:

In reply to your memo of January 13, the cable from Corson sent from Istanbul and a later memorandum from him here, I have prepared a report in three sections - 1) accomplishments, 2) work for remainder of fiscal year, and 3) $2,000,000 economic aid program. The original with map is in Mr. Corson's secretary's hands awaiting his return from Dhahran where he has been for the last two weeks.

As to Malcolm Jones' points - I do not know whether water for camel and goat herds would be considered agricultural. USAOM/Jidda has a range man here in their agricultural section. It seems to me that he is splitting hairs, but he is right in not identifying it as agricultural water.

As to the coastal strip on the Red Sea, we have explored it except for the Tihama esh Sham (already we have wells for water at Qunfida and Lith) and have it down for exploration for agricultural water, and a small block northeast of Jidda.

Your outline is essentially correct. However, we may be able to find some substantial supplies for agriculture in the fringe sandstones and in the Jauf-Sikaka basin (including the Tebuk area which could be either "basin" or "fringe").

I am trying to set up an independent water agency within the Saudi Government. The King asked me to work with Prince Sultan, now Minister of Agriculture, and we have drawn up parallel organization charts for him, one for Agriculture, one for Water Resources, with a Director-General for each. Today all the drilling rigs are being transferred to Sultan from the Ministry of Finance, and shortly I hope we will be rolling but there are still some obstacles within the Saudi Government. I am slated to go on a reconnaissance of the old Medina-Amman Railroad; then I shall go out to Dhalm and south to Dhahran al Yemen to help on the laterite work. The trip to the railroad should take ten days - the later trip two weeks.

Kind regards to the people in the office.

Sincerely,

Glen F. Brown, Chief
Natural Resources Division

cc: ✓Mr. Corson, Director
USAOM/Saudi Arabia

PS - In the interest of time I put the program in a letter to Bill which went out yesterday. Please check with him for transmittal to you.

GFBrown:o

NR Rpts ②

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

December 31, 1953

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HJCorson:o

NR Rpts

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

MEMORANDUM December 1, 1953

TO: Harland J. Gerson, Director
USA Operations Mission, Saudi Arabia

FROM: Roy O. Jackson, Acting Director
Natural Resources Division

SUBJECT: Monthly Report for November, 1953

The monthly reports of Mr. Bogue and Mr. Goudarzi are attached. The more important accomplishments and activities of the Natural Resources Division are listed below:

1. Two production wells for the city of Yenbo were completed. Mr. Goudarzi supervised pumping tests of these wells and analyzed the water samples. These wells should insure a satisfactory Yenbo city water supply.

2. Mr. Goudarzi supervised a pumping test on a well at Wejj. This well is being considered for supplying the village of Wejj.

3. Mr. Goudarzi continued work on the geological reports and maps dealing with the proposed Jidda - Riyadh railroad.

4. Mr. Bogue completed the report, in collaboration with Mr. Twitchell, of the Zalm (Dhalm) gold-silver mine.

5. An inspection and reconnaissance trip was made south of Jidda, along the coastal plain, to Qizan.

    (a) Well locations for a Lith city water supply were made. Two wells were completed during the month. Pumping tests have not been made, but the water appears to be fresh and sufficient.

    (b) A series of locations were picked in the Qunfida - Hali region for a proposed drilling program there.

    (c) An inspection was made of the Darb region. Two fresh water wells were completed and an additional location was picked.

    (d) An inspection was made of the Sabya - Wadi Qizan area. Additional drilling locations were picked. All wells completed in this region have produced water satisfactory for irrigation purposes.

6. The drilling program, under the Division's supervision, continues in the Taif region.

7. Wells #5 and #6 were completed in the Khulais region.

8. The relations between FOA, Baker and SAG have been of prime concern to the division during the month. FOA has been informed that the contract for the SAG water Resources Division of Baker has been awarded the German concern effective January 1, 1954. Information concerning these matters is contained in other communications.

ROJ/pa

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

MEMORANDUM December 1, 1953

TO: Mr. R. O. Jackson
Acting Chief, Division of Natural Resources

FROM: Richard G. Bogue

SUBJECT: Monthly Report - November 1953

The report on the Zalm (Dhalm) mine by Mr. K. S. Twitchell and myself was completed. One day was spent in the Khulais area with Mr. Sinclair of the Transportation Department. The rest of the month was spent in the office on maps, photos and general office work.

Two days were lost due to rain and the office roof leaking.

RGB/pa

USA OPERATIONS MISSION TO SAUDI ARABIA
Jidda

MEMORANDUM December 1, 1953

TO: Mr. Roy O. Jackson
Acting Chief, Natural Resources Division

FROM: Gus H. Goudarzi, Geologist

SUBJECT: Monthly Report - November 1953

During November 1953 a geological report on the proposed Jedda-Riyadh RR Route was completed (rough draft) and a sketch map of the route was drawn.

A visit was made to Yenbo Nakhil after the completion of the drilling operations. Test pumping of YnX-3 well was conducting using YnX-4 as an observation well. YnX-4 well was also tested. Water samples were taken and analyzed. The results of the above examinations were incorporated in a report submitted on November 22nd.

A dug-well at Wejj was also test pumped in connection with the city water supply.

GHG/pa

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Jidda

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GHG/pa

NR - Rpts

File 1
2
Chron.

FOREIGN OPERATIONS ADMINISTRATION
Jidda, Saudi Arabia
October 3, 1953

MEMORANDUM

TO: Mr. John A. Dunaway, Acting U. S. Director of Technical Cooperation in Saudi Arabia

FROM: Donald F. Dougherty, Acting Chief, Natural Resources Division

SUBJECT: Monthly Program Summary - September 1953

The geologic investigation at Lith, started in August, was completed early in September. This was for the purpose of recommending sites to be drilled to obtain a water supply for Lith. Drilling has not yet been started as all drillers were otherwise occupied.

Field trips to Taif and Khulais areas were made to check on progress of drilling there.

The map compilation to accompany the geologic report on the proposed Riyadh-Jidda railroad was completed during the month.

A field trip was made to Yenbo-Medina area to check on the progress of the drilling in Yenbo-Nakhl and to complete the geologic mapping on that part of the Riyadh-Jidda railroad.

A water well producing about 500 gallons per minute and another producing about 200 gallons per minute were completed and tested during the month in Wadi Khulais. It should now be possible to start intensive work on the agricultural development of this area.

DFD

DFDougherty:o

Natural Resources.

File 1
2
Chron.

Jidda, Saudi Arabia

September 9, 1953

MEMORANDUM

TO: Mr. D. F. Dougherty
Acting Chief, Natural Resources Division

FROM: Richard O. Bogue
Geologist

SUBJECT: Lith Water Supply

A request was received from the Assistant Deputy Minister of Finance to investigate the possibilities of a water supply for the town of Lith. It was thought that the well, called Bir Assalia, might possibly furnish enough water.

The period from August 26 to September 4 was spent in the vicinity of Lith investigating the possibilities of water in the area. The Emir of Lith, Ibrahim Bin Mokran, and the Director of the Finance Department of Lith, Hamza Hashim, were both very helpful and cooperative.

The well, Bir Assalia, and the surrounding area were examined and it is recommended that this well not be considered as a water supply for the town of Lith. The well is in schistose rocks and would probably not yield enough water.

Given for [illegible]

The areas to the north and south of Bir Assalia were examined and the best possibilities to drill and develop wells were found in Wadi Lith. Three sites were chosen, two near Bir Shabwa at the confluence of Wadi Beithahn and Wadi Lith, and the other in the main channel of Wadi Lith.

Transmitted
9-13-53

Site 1 - Located 100 feet north of a blazed tree which is 100 feet northward from Bir Shabwa.

Site 2 - Located 100 feet north of blazed tree which is between 800 and 900 feet southeast of Bir Shabwa.

Site 3 - Located approximately 2½ kilometers southeast of Bir Shabwa. The site is on a sandy knoll in Wadi Lith. There is a blazed tree 600 to 700 feet north of the site.

All three sites were shown to Abdullah bin Hamdan, a guide on the staff of the Emir of Lith.

It is recommended that the well at Site 3 be drilled first as this place offers the best possibilities of a single well producing enough water to supply the town. There is a good reservoir site on the small hill on the north side of the Wadi. The airline distance from Lith to Site 3 is between 13 and 14 kilometers (scaled from aerial photography). The difference in elevation between the site and Lith is not known. An attempt was made to measure the elevation difference with an aneroid barometer, but the unsettled weather made the readings unreliable.

It is recommended that this well be drilled and a pumping test made to determine the amount of water. If the amount of water is sufficient, a survey may then be made for the pipe line and reservoir site.

The distance from Lith to Sites 1 and 2 is approximately the same, between 13 and 14 kilometers, and there is a good reservoir site on the west side of Wadi Beithahn. However, it is believed that it will not be necessary to drill wells at these two sites.

RGBogue:o RGB.
OTD

Given for Fuad Naj
for translation +
transmittal
9-13-53